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.-Gen. G. E. WILDMAN-
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orial Director
J. M. LANCASTER

cutive Editor
DAPHNE L. MERMIKIDES

dvertising Manager
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NITROGEN

THE MAGAZINE OF WORLD NITROGEN

contents

	page
Spain's Nitrogen Industry: Capacity scheduled to rise to 390,000 tonnes N by 1965	1
Isoycanates: Production, consumption, applications	11
Supplies, Prices, Trends: World Nitrogen Production and Consumption at New Peak	18
Freights: Strong Seasonal Activity in Outward Freight Markets from Europe	25
Aikman Half-Yearly Report	28
Nitrogen Fertilizers in Australia: Duty on imported N fertilizer: N fertilizer requirements: ICIANZ's N fertilizer project	31
Colombia's Nitrogen Fertilizer Production: Barrancabermeja plant now near to completion	34
Hungary's Expanding Nitrogenous Fertilizer Industry: Output expected to rise to 720,000 tonnes product by 1965	37
Alkali Inspectors' Report: Decline in production of concentrated ammonia liquor	39
Urea as Inhibitor of Auto-oxidation in Fertilizers: Ensures satisfactory storage properties in bulk and in paper sace	41
Dimethylol Ethylene Urea Plant for Russia: Manufacturing process and commercial applications	42

Current Events

United Kingdom	Caprolactum and Nylon-6 Projects	43
India	Nangal Fertilizer Works	43
Australia	Nitrogen for Steel Works at Port Kembla	44
United States	Southern Nitrogen to Increase Ammonia Production by 50%	44
	Armour's Nitrogen Fertilizer Complex	44
	Phillip's Ships Refrigerated Ammonia by Barge	45
	Olin Hydrazine Plant Operating	46
West Germany	Treatment of Ammonia Liquor	46
Netherlands	Ammonia Plant at Delfzijl	46
Norway	Norsk Koksverk's Ammonia Plant Project	46
Czechoslovakia	Slow Expansion of N Production	47
Poland	Urea Plant Ordered from Power Gas	47
Japan	Kyowa Group Organization and Expansion	48
Egypt	Fertilizer Operations in Aswan	48

Company Reports

Staatsmijnen Nitrogen Production Increased 6% in 1960	49
Montecatini Reports Steep Rise in Fertilizer Nitrogen Production	50
Scottish Agricultural Industries Expand Ammonium Phosphate Capacity	50
Monsanto Reports Highest-ever Ammonium Nitrate Sales	51
W. R. Grace's Sales and Profits From Fertilizers Rose in 1960	52
African Explosives and Chemical Industries' Increased Fertilizer Sales	52
Index to Advertisers	xii

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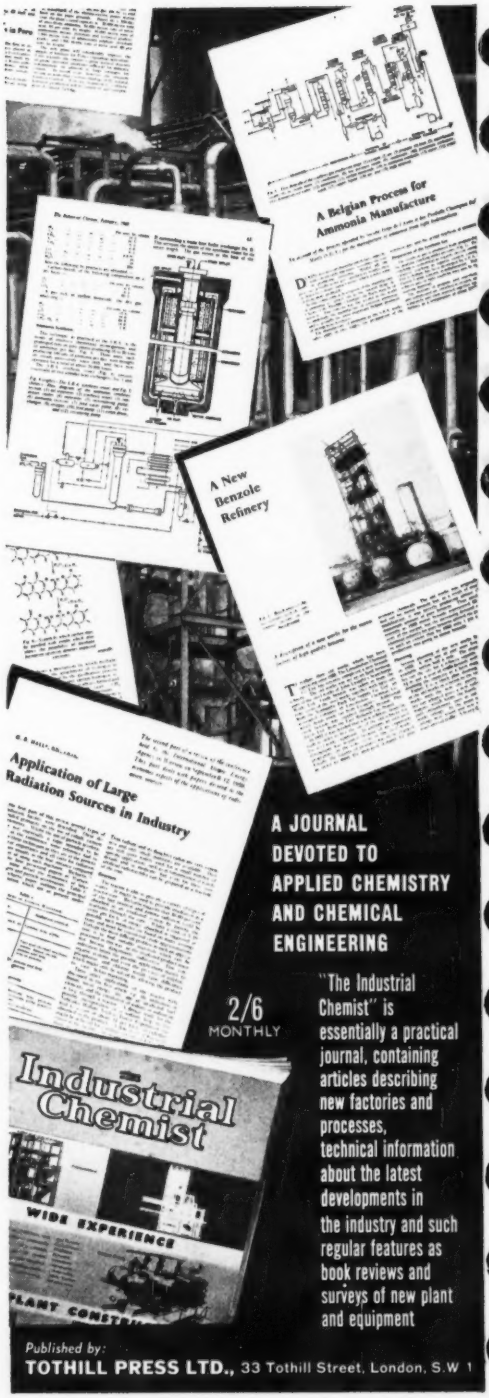
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The Survey may be purchased in its entirety, or in separate volumes: special rates will apply to libraries and technical institutes.

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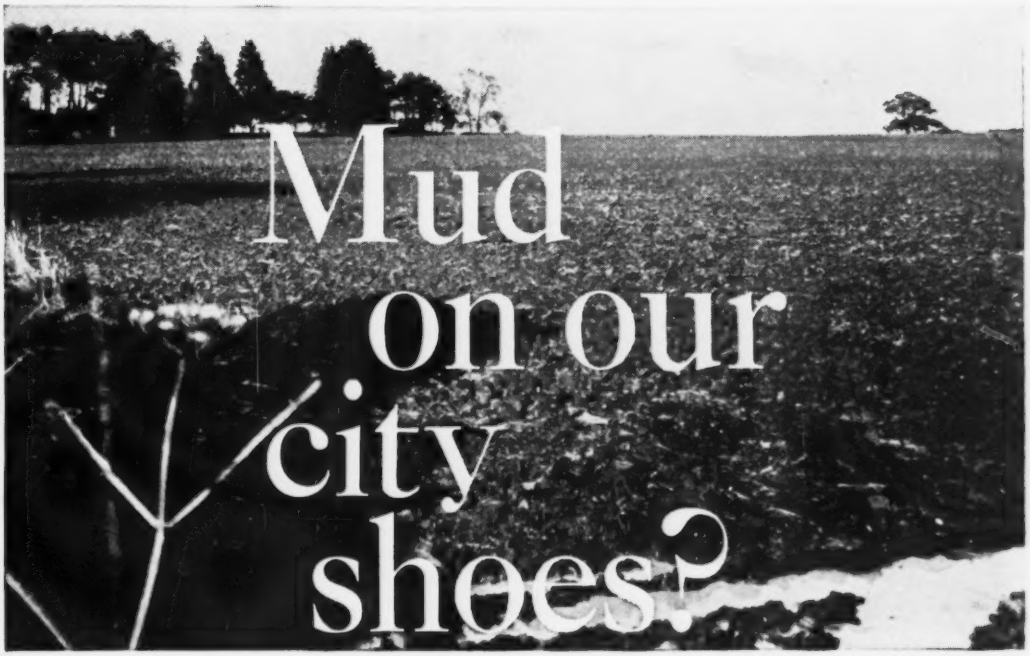

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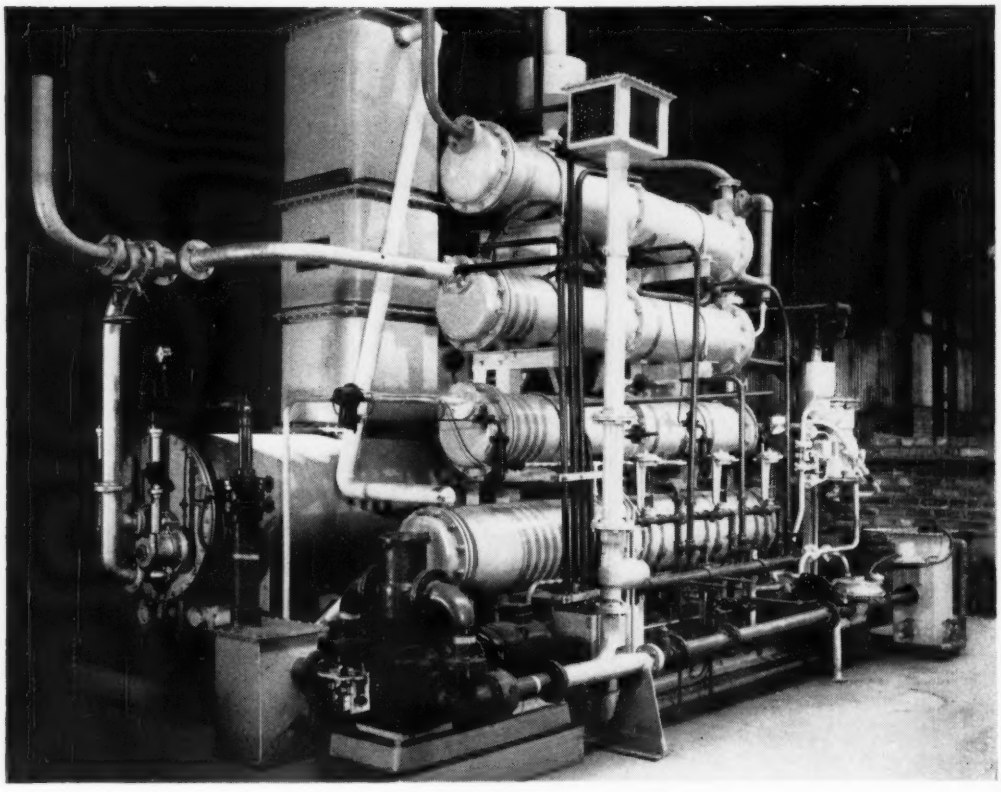

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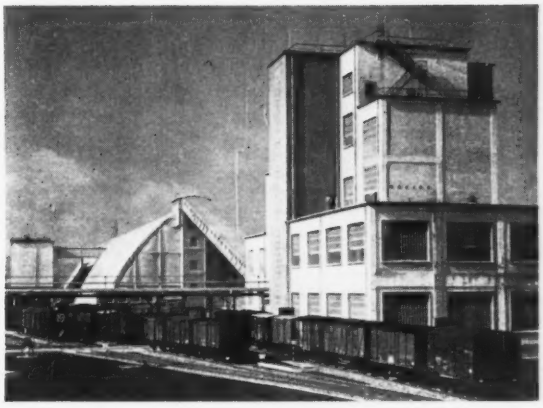
Spain's Nitrogen Industry

Capacity scheduled to rise to 390,000 tonnes N by 1965



Drying section and storage building for nitrogen fertilizers of ENCASO at Puertollano

THE problems which impede Spanish agriculture are those associated with impoverished soils, lack of adequate annual rainfall in many parts of the country and primitive methods of husbandry. While increased acreages, improved plant varieties and agricultural techniques, will all contribute to increased agricultural output, by far the greatest increases in crop production will result from an expansion of the irrigated area, and from the increased use of fertilizers. A steady and sizeable expenditure of foreign exchange on imported fertilizers is impracticable, however, and the Government has decided that national production must be greatly increased. At present, only some 10% of the cultivated area is irrigated, but rapid progress in increasing irrigation cannot be expected owing to the very high expense involved, and consequently the most immediate and effective measure in raising crop yields is increased fertilizer use.

Consumption

Before the outbreak of the Spanish Civil War, nitrogenous fertilizer consumption in Spain had reached a level of some 115,000 tonnes N, of which local production provided some 4,000 tonnes N, and the remainder was imported. During the Civil War, imports and local production were both drastically reduced and consumption fell to a very low level and in the period 1941-48 consumption of fertilizer nitrogen averaged less than 20,000 tonnes annually, but has since recovered. By 1954 it had reached a level of 117,000 tonnes N, approximately equivalent to the amount used just prior to the outbreak of the Civil War. Since 1954, nitrogen consumption has doubled, and 1959-60 consumption is estimated at 235,000 tonnes N, which is, however, below the very high level achieved in the previous year.

Spanish Nitrogenous Fertilizer Consumption

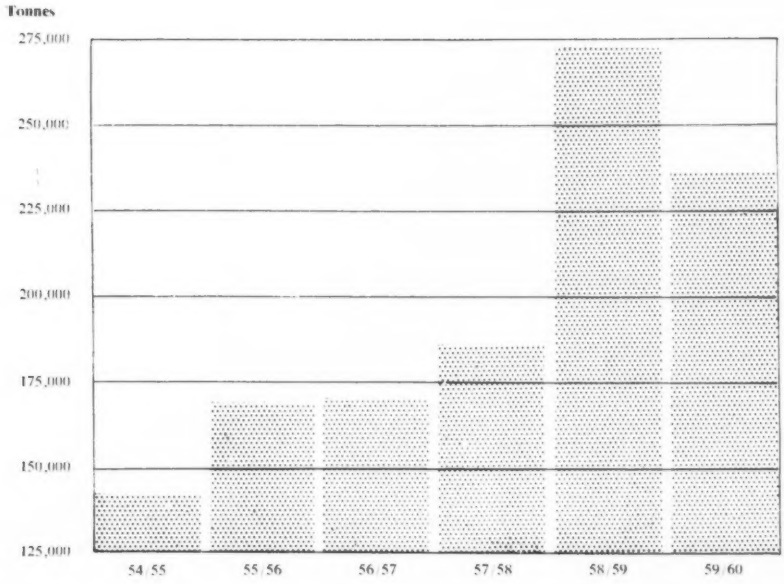
tonnes N

1954-5	...	142,600	1957-8	...	185,948
1955-6	...	171,678	1958-9	...	273,800
1956-7	...	171,768	1959-60	...	235,000

Use Pattern

Ammonium sulphate is the most important material and in 1958-59 consumption totalled 189,100 tonnes N or nearly 70% of the total Spanish nitrogenous fertilizer market. In the following year, 1959-60, consumption decreased to 143,600 tonnes N, but ammonium sulphate still accounted for over 61% of the total market.

Spain has also been a heavy user of nitrates of lime and soda, since the high hygroscopicity of these nitrate forms presents no problem under the arid conditions prevailing in many parts of the country. As a result of the substantial production in Western Germany of calcium ammonium nitrate and ammonium sulphate nitrate in post-war years both these fertilizers have increased in popularity in Spain, and their use has trebled over the last six years. Small amounts of calcium cyanamide have also been used but consumption of this material has declined over recent years and amounted to only 500 tonnes in 1959-60.



Spanish nitrogenous fertilizer consumption 1954-55 to 1959-60

Nitrogenous Fertilizer Consumption
'000 tonnes N

	1958-9	1959-60
Ammonium sulphate	189.1	143.6
Calcium ammonium nitrate ...	21.3	27.9
Ammonium sulphate nitrate ...	18.4	28.8
Calcium nitrate	19.3	19.9
Nitrate of soda	25.0	14.3
Calcium cyanamide	0.7	0.5

It is estimated that nearly 60% of all nitrogen used is applied on cereals, of which the most important by far is wheat. Other significant users of nitrogen include root crops (10% of all nitrogen applied) citrus (9%) and vegetables (8%).

Production

Although Spain was one of the first countries in the world to undertake the manufacture of nitrogenous fertilizers the industry was slow to develop and production of these fertilizers up to 1951 never exceeded 4,200 tonnes N. Since 1951, however, there has been a progressive expansion in productive capacity up to the present level of over 150,000 tonnes N. Actual production has so far never reached this level, although in the 1960-1 fertilizer year, it is expected to reach 129,000 tonnes N.

Of the 11 plants in Spain currently engaged in producing nitrogenous fertilizers, four produce ammonium sulphate only, two produce calcium ammonium nitrate and two produce both calcium ammonium nitrate and ammonium sulphate. With the exception of plants operated by Sociedad Iberica del Nitrogeno (S.I.N.), by Sociedad Espanola de Fabricaciones Nitrogenados (SEFANITRO), and by Empresa Nacional de Calvo Sotelo (ENCASO), they all have very small capacities. In addition small quantities of calcium cyanamide are produced by Hidro-Nitro Espanola S.A. at Monzon and Union Quimica del Norte de Espana S.A. at Mataporquera, the combined capacity being equivalent to some 6,000 tonnes N.

Sociedad Iberica del Nitrogeno (S.I.N.). Ammonia is produced by Sociedad Iberica del Nitrogeno at La Felguera and at Barros, the respective capacities of ammonia being 40 tonnes and 80 tonnes per day. At La Felguera, hydrogen for ammonia manufacture is extracted from coke-oven gas obtained from the coke-ovens of Duro-Felguera and nitrogen is produced by air-separation at Barros and transported to La Felguera. Ammonia produced by the Claude process, is not further processed at La Felguera but is piped to Barros, three-quarters of a mile away, for eventual nitrogenous fertilizer manufacture.

At Barros, water-gas is used as one of the raw materials for synthesis gas production, the other, nitrogen, being obtained from the air separation plant. Ammonia produced at both Barros and La Felguera is used in the manufacture of the following intermediates and end-products:

Product	Capacity (tonnes per day)
Nitric acid (53%)	280
Ammonium nitrate, technical	30
Calcium ammonium nitrate (20.5% N) ...	280
Ammonium sulphate	150

Sociedad Iberica del Nitrogeno produces sulphuric acid at Barros by the contact process using pyrites as a raw material. Capacity of the plant is 67 tonnes per day of 98% acid and the entire output of the plant is used captively for ammonium sulphate manufacture.

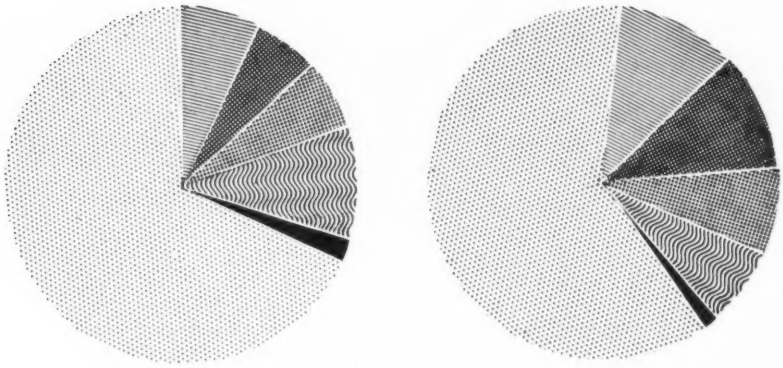
Sociedad Espanola de Fabricaciones Nitrogenados (SEFANITRO). Nitrogenous fertilizers are produced by SEFANITRO at both Bilbao and at Sagunto. At the former location, a 24,000 tonnes N ammonia plant was established in 1951 which was later expanded by 50% to 36,000 tonnes N. Gas for hydrogen manufacture is provided from the coke-ovens of Altos Hornos de Vizcaya S.A., and nitrogen is obtained from an air-fractionation plant of Linde design. Ammonia is produced by the Haber Bosch process and the entire output is used for ammonium sulphate manufacture (capacity 180,000 tonnes) using sulphuric acid produced by SEFANITRO.

At Sagunto, SEFANITRO also uses coke-oven gases for ammonia and ammonium sulphate manufacture, but output is small and is equivalent to some 2,000 tonnes N annually.

Empresa Nacional de Calvo Sotelo (ENCASO). Two nitrogenous fertilizer plants were brought on stream late in 1959 by ENCASO, a subsidiary of Instituto Nacional de Industria. At Puertollano, an industrial complex was set up to utilise indigenous supplies of coal, bituminous shale, pyrites and limestone for the manufacture of lubricants, solvents and other hydrocarbon products and also sulphuric acid, nitrogenous fertilizers and technical nitrogen products. Hydrogen is produced by the gasification of brown coal by a Winkler-type process, and nitrogen is produced in an air-separation plant designed by Linde. Ammonia is manufactured by a modified BASF process and the capacity is equivalent to some 18,000 tonnes N. The complex is able to produce 80,000 tonnes of nitrogenous end - products which include calcium ammonium nitrate, sulphate of ammonia and technical grade ammonium nitrate.

Aerial view of the fertilizer works of Nitratos de Castillos, at Bilbao

Nitrogenous Fertilizer Consumption in Spain



In addition, a small quantity (5,200 tonnes) of sulphate of ammonia is produced as a by-product in the manufacture of solvents, lubricants, etc., based on the distillation of shale oil. The complex has an integrated sulphuric acid plant of 200 tonnes per day capacity due on stream this year which will utilise pyrites mined in the Huelva region. The output of the sulphuric acid plant will be entirely consumed captively for the manufacture of nitrogenous fertilizers and in shale oil refining.

At the Puertollano complex, nitrogenous end-products capacities are well in excess of ammonia capacity, and there is consequently considerable flexibility in production as shown by the following:

Product	Capacity (tonnes per annum)
Ammonium sulphate (21% N)	70,000
Calcium ammonium nitrate (20.5% N) ...	50,000
Technical ammonium nitrate (34.8% N)	26,000
Concentrated nitric acid (98%)	4,000

Ammonia capacity is currently being expanded to reach 45,000 tonnes N by 1964 but will only require a relatively small increase in fertilizer capacity.

At Puentes de Garcia Rodriguez, ENCASO manufacture 100,000 tonnes of nitrogenous fertilizers, equivalent to some 20,000 tonnes N. Hydrogen is produced by the gasification of lignite using the Koppers-Totzek process and nitrogen is obtained in a Linde air-separation plant. The entire ammonia output is used for the manufacture of calcium ammonium nitrate, 20.5% N.

Nitrogen capacity is being increased by 50% to 30,000 tonnes N and by 1964 the capacity of ENCASO's two plants will together total 75,000 tonnes N.

A plan by ENCASO to manufacture some 30,000 tonnes N in the form of ammonium sulphate at Escatron using lignite as a raw material has been under consideration since 1954 but plans have now been indefinitely postponed.

Nitratos de Castilla. Nitrogenous fertilizers are produced by Nitratos de Castilla at Valladolid using as raw materials electrolytic hydro-

gen and nitrogen obtained by air-fractionation. The capacity of the plant is equivalent to 14,000 tonnes N entirely in the form of calcium ammonium nitrate 20.5 % N.

In the future, calcium ammonium nitrate capacity at Valladolid will double to 130,000 tonnes.

Compania Insular del Nitrogeno, S.A. (CINSA). The 22,000 tonnes per annum N plant of CINSA S.A. came into full operation at Teneriffe, Canary Islands, during March this year, the shareholders in the new plant including Compañia Española de Petroleos S.A., Industrias Quimicas Canarias S.A. and Banco Central. The plant operates on a petroleum hydrocarbon feedstock supplied from the adjacent refinery of Compañia Española de Petroleos S.A. and uses the Texaco gasification process. At the complex, sulphuric acid capacity based on pyrites amounts to some 250 tonnes per day which is used for the manufacture of 110,000 tonnes of ammonium sulphate.

Consumption of fertilizer nitrogen in the Canary Islands has risen to some 15-20,000 tonnes N, and it is anticipated that virtually the entire output of the CINSA plant will be marketed locally.

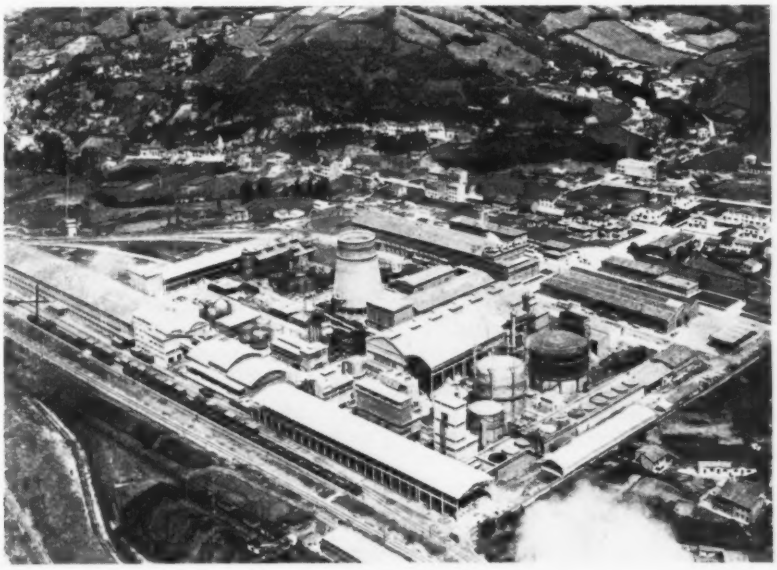
Energia e Industries Aragonesas S.A. At Sabinanigo, Energia e Industrias Aragonesas S.A. produces some 6,000 tonnes N in the form of ammoninm sulphate. Hydrogen is obtained by electrolysis. This company, through its subsidiary, Compañia Aragonesa de Industrias Quimicas S.A., is at present the sole producer of urea in Spain, but the output from its Pechiney plant is small (2,000 tonnes) and is all used industrially.

By-product Ammonium Sulphate

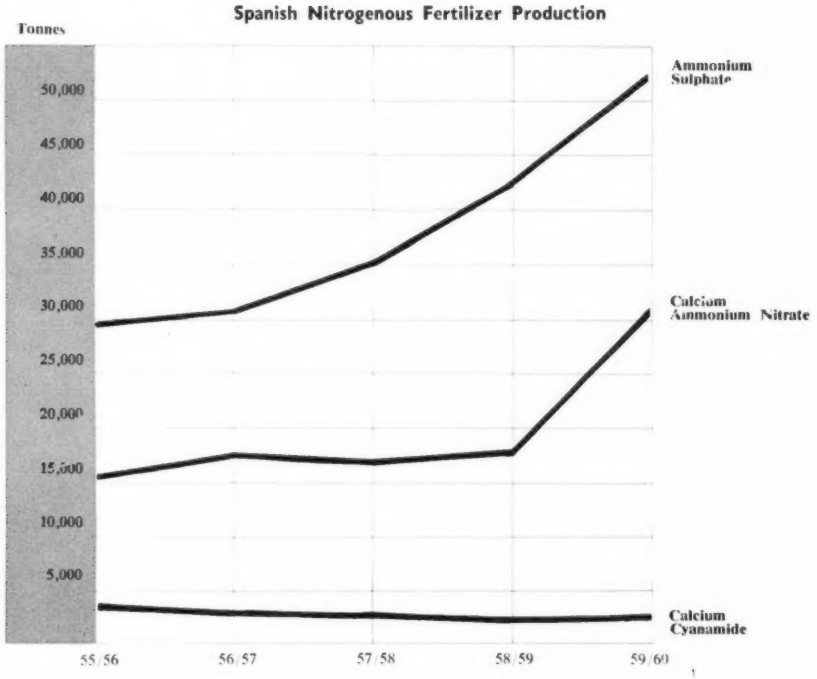
There is a small production of by-product ammonium sulphate (30,000 tonnes) from the coking plants of Alto Hornos de Vizcaya S.A. and Sociedad Metallurgica Duro-Felguera S.A. and from town gas works.

Future Expansion

Spanish nitrogen capacity will markedly increase when three large plants, at present under construction, come into operation. At Aviles, a large 40,000 tonnes per annum N plant is in partial operation, and is likely to come into full operation this year. The operating company, Empresa Nacional de Siderurgica, an associate of Instituto Nacional de Industria, will utilise coke-oven gas for hydrogen manufacture and the entire output of the fertilizer plant will be in the form of ammonium sulphate (200,000 tonnes per annum).



Panoramic view of the fertilizer plant of Sociedad Iberica del Nitrogeno at its Barros works



Refineria de Petroleos de Escombreras S.A. (REPESA), have commenced construction of an 88,000 tonnes per annum N plant alongside their refinery at Cartagena. Escombreras, INI, Caltex and Cepsa, will all participate in the project. Synthesis gas will be produced by the gasification of refinery products using the Texaco gasification process and ammonia will be manufactured in a plant designed by Friedrich Uhde G.m.b.H. End-products from the fertilizer complex will include urea (32,000 tonnes N), ammonium sulphate (41,000 tonnes N) and anhydrous ammonia (12,000 tonnes). The total cost of the project is estimated at U.S. $35 million, of which $10 million have been provided as a loan by the Export-Import Bank. The plant is scheduled to come on stream in the early part of 1963.

A new company, Abonos Sevilla, has been formed by the two main participants, Sociedad Iberica del Nitrogeno S.A., and Union Española de Explosives, to manufacture nitrogenous fertilizers at Seville using a feed-stock of fuel oil. Fixed nitrogen capacity will be equivalent to some 37,000 tonnes N and end-products will include 60,000 tonnes calcium ammonium nitrate (20.5% N), 126,000 tonnes of complete compound fertilizer and ammonium sulphate as well as nitric acid and sulphuric acid for use as intermediates in fertilizer production. The total cost of erecting the fertilizer complex is estimated at $27 million, and it is expected on stream by mid-1963.

Nitrogenous Fertilizer Production in Spain

'000 tonnes N

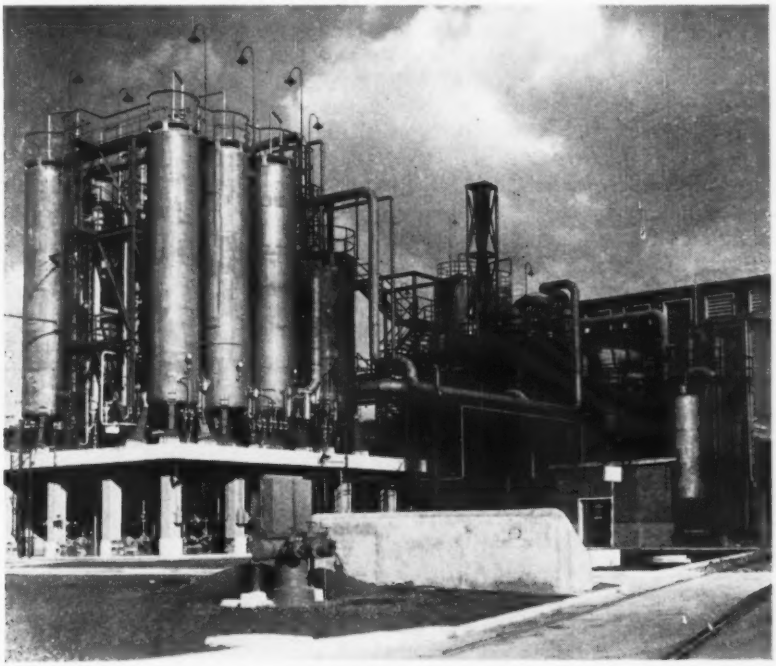
	1955-6	1956-7	1957-8	1958-9	1959-60
Ammonium sulphate	28.0	29.5	33.7	40.9	50.7
Calcium ammonium nitrate	14.2	15.8	15.1	16.1	29.7
Calcium cyanamide	2.2	1.2	1.0	0.6	0.6
Total	**44.4**	**46.5**	**49.8**	**57.6**	**81.0**

Mixed Fertilizer Consumption

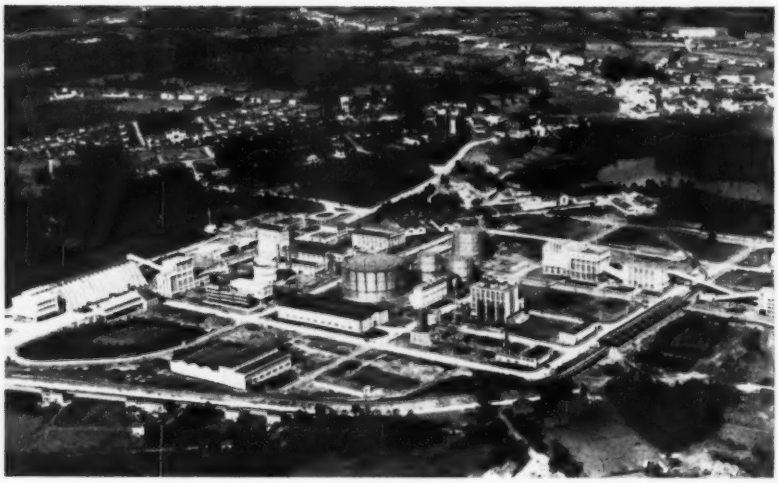
Actual production of nitrogenous fertilizers in Spain has increased from a level of 48,040 tonnes in 1951, to a level of 458,500 tonnes in 1960. Ammonium sulphate, which in 1951 accounted for 70% of total nitrogenous fertilizer production, has declined slightly in relative importance since, but remains the most important locally produced material and accounted for 62.6% of total production in 1959/60. Production of mixed fertilizers, at present small, is increasing and it is estimated that some 10-12% of all ammonium sulphate consumed was utilised in the form of mixtures. With a substantial output of high analysis complete compound fertilizer planned by Abonos Sevilla, consumption of this material will increase although it is doubtful whether domestic demand for this type of product will have grown sufficiently to absorb the entire output of the plant. Large quantities of fertilizer grade urea will also be manufactured in the future, but this material is not currently used as a fertilizer in Spain and it is likely that considerable quantities will be exported initially.

Imports

Local production of nitrogenous fertilizers has never been sufficient to supply more than one-third of total requirements and considerable quantities are imported every year. Spain, in fact, provides the largest export market for nitrogenous fertilizers in Western Europe, and has long been regarded by Western European suppliers as an important outlet for nitrogenous fertilizer export surpluses. Ammonium sulphate, imports of which have increased more than threefold since 1954, accounts for the largest share of N fertilizers. Germany is the major supplier of this material and significant quantities have also been imported from the U.S.A., Holland and Belgium, and, in recent years, from Austria, France and Italy. The United Kingdom, which was a major supplier in pre-war years, has declined in importance and now supplies less than 3% of imported ammonium sulphate. Spain has always been a large importer of natural sodium nitrate from Chile, and synthetic calcium nitrate from a variety of sources of which the most important are Norway and West Germany, since both of these materials are considered suitable for use



Nitric acid plant of ENCASO at Puertollano



Fertilizer and associated chemical plants of ENCASO at Puentes de Garcia Rodriguez. The storage building is on the left

under the arid conditions prevailing in many parts of the country.

In post-war years substantial quantities of both calcium ammonium nitrate and ammonium sulphate nitrate have been available for export from Western Europe, and as a result imports of these fertilizers into Spain have increased. It is expected, however, that imports of the former will decline owing to expanding domestic production.

During 1959 the Government declared its intention of imposing an import duty on nitrogenous fertilizers which were previously imported free of duty, the new tariff becoming operative at the beginning of 1960. As a result, in the period before the new tariff came into force imports were substantially increased resulting in the establishment of very large stocks at distributors' wharehouses. During 1960 the Government placed an import duty of 10% *ad valorem* on all synthetic nitrogenous fertilizers currently imported and a fiscal tax was also imposed varying between 3 and 5% (depending on the type of fertilizer) on the c.i.f. value (plus duty) of nitrogenous fertilizers. In addition the Government imposed an anti-dumping duty of pesetas 420 per tonne. Partly because of the large stocks which had been built up in the previous year, but mainly because of the new restrictions, nitrogenous fertilizer imports were sharply curtailed during 1960. It will be, however, a number of years before local production is able to supply total domestic requirements, and in the intervening period Spain will remain a very substantial importer of nitrogenous fertilizers.

Distribution and Prices

The domestic producers and importers of nitrogenous fertilizers maintain large central stores and smaller stocks are held by distributors who obtain their supplies from both of these sources. Prices are quoted on a "delivered nearest station" basis, and since the Government fixes the maximum selling price there is a tendency for a particular area to be supplied more or less entirely from the central factory or main store nearest that area. In the price fixed by the Government, provision is made for the fertilizer carriage, but owing to the great size of the country, movements of fertilizers beyond a certain distance from the

Spanish Nitrogenous Fertilizer Imports

tonnes

	1954-5	1955-6	1956-7	1957-8	1958-9	1959-60
Ammonium sulphate	344,626	377,422	395,597	420,357	700,541	394,494
Ammonium nitrates	20,974	92,394	97,939	76,298	101,658	63,684
Nitrate of soda	112,349	155,456	143,703	130,626	146,663	67,421
Calcium nitrate	55,749	68,655	54,960	54,551	135,858	91,826

Fertilizer factory of Abonos Sevilla S.A. at Tablada, Seville

factory or store become uneconomic. As a result, the major manufacturers and suppliers have a virtual monopoly of suppy in areas adjoining their fertilizer stores.

A direct subsidy on fertilizers is not generally given to the farmer, the Government encouraging increased fertilizer usage by setting the maximum selling price at what it considers a sufficiently attractive low level. However, for fertilizers distributed through the Servicio Nacional del Trigo (National Service for Wheat) the Government has granted for autumn sowing operations the following subsidies to the farmer:

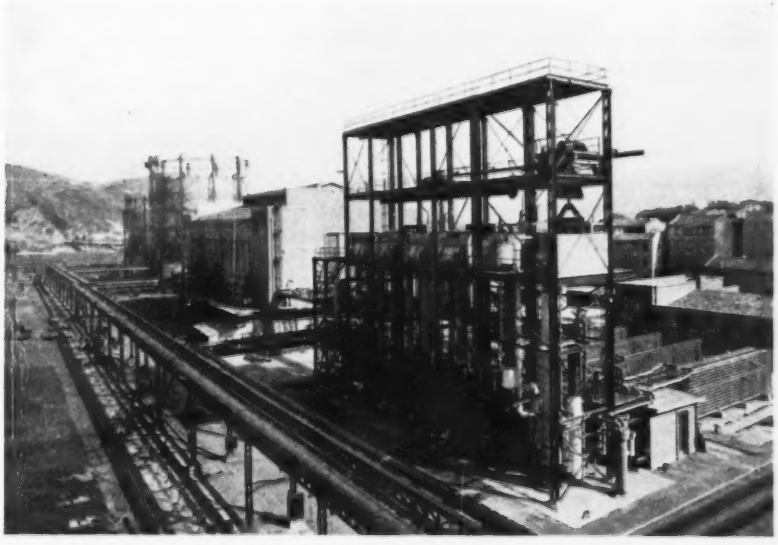
Calcium ammonium nitrate ...	Ptas 600/tonne
Ammonium sulphate	Ptas 372/tonne

The subsidies on both these materials will be maintained for the spring campaign.

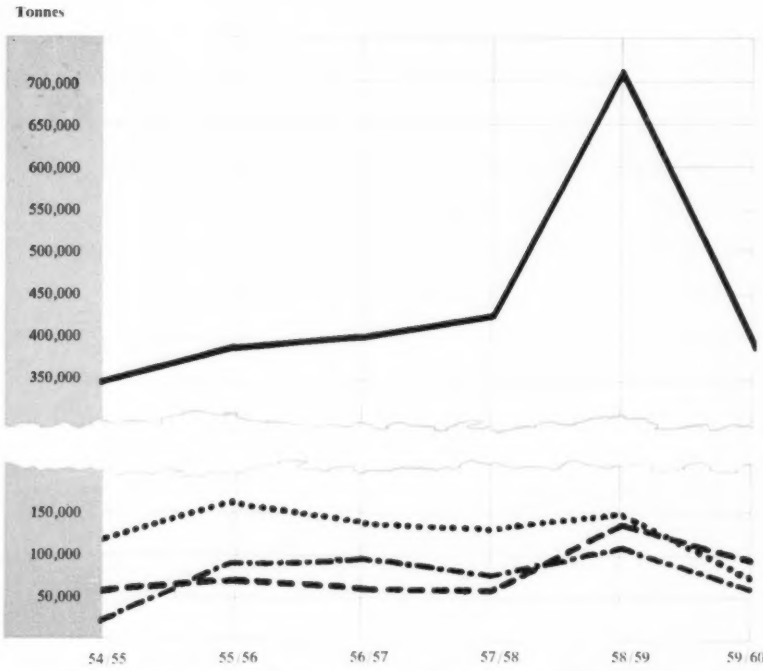
The current prices for ammonium sulphate in Spain vary between Ptas 2,982-3,050 ($49.50 to $50.60) per tonne f.o.r., packed in 100 kg. jute or jute-paper bags, and calcium ammonium nitrate retails at Ptas 3,295 to 3,337 ($54.65 to $55.30) per tonne f.o.r., same packing.

Outlook

A number of schemes to achieve self-sufficiency in agricultural production are being undertaken by the Government. They include the provision of large-scale irrigation facilities, credit facilities for farmers, and in some cases guaranteed minimum prices for agricultural produce. As a result fertilizer requirements will expand but it seems probable that many years



Ammonia synthesis plant of Soc. Espanolade Fabricaciones Nitrogenados (Sefanitro)



Spanish nitrogenous fertilizer imports 1955-56 to 1959-60

will elapse before Spain achieves self-sufficiency in nitrogenous fertilizers production. Capacity as a result of projects planned and under construction, is scheduled to rise to a level of some 390,000 tonnes N by 1964. It is doubtful, however, whether production will attain this level by the date specified and imports are likely to be maintained at a level of 100,00 tonnes N at least for the next two or three years.

Nitric Acid Vapour Phase Technique For Removing Iron Oxide Film

FACED with the problem of removing a film of iron oxide and metallic iron from the stainless steel 304 clad interior surface of two new atomic reactor vessels of 94ft. by 32ft. and 9ft. by 26ft. internal measurement and providing a passive, rust-free surface C. M. Louchs (Westlake, Ohio) and W. B. Brown (Hydrosol Systems Inc., Bedford, Ohio), decided to use nitric acid vapour phase technique.

Openings were stoppered, except one on the lowest part of the vessels as they lay on their sides. That opening was equipped with a plastic leg extending into a stainless steel pan below. Steam from a travelling crane with 42°Be technical grade nitric acid added by means of a small stainless steel pump handling up to 2 quarts per minute was introduced through an open-end stainless steel pipe inserted into the vessel.

Most of the iron was found to be removed in the first few minutes of exposure. When it was decided to discontinue the acid treatment steam was allowed to continue entering the vessel to rinse the surfaces. Afterwards the inside was hosed down with demineralized water and ports opened to allow ventilation and drying. Copper sulphate tests after cleaning showed the surfaces to be free from metallic iron.

	Vessel I	Vessel II
Inside dimensions	9ft. x 26ft.	9½ft. x 32ft.
Weight (shipped)	110 tons	180 tons
Gas of 42°Be nitric acid used	78*	52
Time of acid exposure	3½ hr.	3 hr.
Volume of condensed acid	30%	20%
Dissolved Fe in first sample	0.10%	0.33%
Second sample ½-hour later	0.01%	0.02%

* Experimental volume. It is believed that a smaller quantity would have accomplished the same result.

Isocyanates

Production

Consumption

Applications

Fast growing markets for urethane foams mean increased demand for isocyanates and hence for primary and technical nitrogen

Urethane foam for a tractor seat undergoing tests

ALTHOUGH in recent years the sudden spectacular growth of demand for new chemical products has become commonplace, the progress of isocyanates is exceptional and has startled even the chemical industry itself. All major producers of isocyanates have expanded or are expanding in the U.S.A. Plant capacity will be almost doubled by the end of this year to 115 million lb.; in the U.K. the major producer, Imperial Chemical Industries Limited, is increasing capacity sevenfold, and in West Germany Farbenfabriken Bayer A.G. is doubling capacity. The main impetus to rising demand for isocyanates, in particular 2.4 and 2.5 toluene diisocyanates (TDI), is the rapidly expanding market for polyurethanes, and by 1965 the U.S. demand for polyurethane foam is expected to be over 350 million lb. a year.

During the period 1885-1900, information was accumulated on the fundamental properties of isocyanates, but it was not until some 40 years later that the practical uses of these compounds was realised. Since 1953, the industrial applications of isocyanates have progressed from virtually none to the point where in one field alone — polymer chemistry — they have become of major importance, for these organic chemicals are building blocks for large polymer molecules.

Methods of Preparation

Of a number of methods of preparation of isocyanates reported in the literature the most common involves the reaction between an amine or its salt and phosgene. Curtius, Hoffmann or Lossen rearrangements and double decomposition reactions have also been widely used.

In 1884, Hentschel obtained an isocyanate by reacting phosgene and the salt of a primary amine. This reaction was modified by Gattermann and Schmidt, who heated molten methylamine hydrochloride with phosgene at 250°C, obtaining methylcarbamyl chloride, which was decomposed by heating with lime.

$$CH_3NH_2HCl + COCl_2 \longrightarrow CH_3NHCOCl + 2HCl$$
$$2CH_3NHCOCl + 2CaO \longrightarrow 2CH_3NCO + CaCl_2 + Ca(OH)_2$$

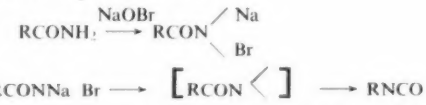
General modifications of this reaction have been developed. The only side reaction of significance in the phosgene processes is the formation of the corresponding disubstituted urea by the reaction of isocyanates with free amine.

$$RNCO + R'NH_2 \longrightarrow RNHCONHR'$$

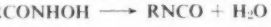
This can be almost eliminated by the use of the amine salt rather than free amine in the liquid phase reactions, or by efficient mixing and a slight excess of phosgene in the vapour phase process.

The method other than the phosgene reaction which has been most used is the Curtius rearrangement of an acid azide in a neutral solvent.

The Hoffmann rearrangement of amides is useful only for those isocyantes which do not react readily with water.



The Lossen rearrangement of hydroxamic acids has not been used frequently.



Diisocyanates molecules contain two isocyanate (NCO) groupings attached symmetrically to a third group of atoms and the latter can be derived from any of numerous simple organic substances. A common diisocyanate formed from isocyanate groupings and a molecule of toluene is toluene diisocyanate, which is a liquid, whereas members of the group with higher molecular weight such as ditoluene diisocyanate are solids. They can be manufactured by continuous processes of high efficiency, from easily obtained raw materials.

Allied Chemicals uses continuous nitration of toluene to dinitrotoluene with subsequent and continuous hydrogenation to toluene diamine which is then treated with phosgene to give toluene diisocyanate. This process has been licensed by Allied Chemical to the Japanese company, Takeda Chemical Industries. I.C.I. is using a similar process.

Uses of Diisocyanates

Diisocyanates are one of the most interesting building blocks for forming large polymer molecules, or they can be reacted with other building block materials to produce both condensation and addition polymers.

Combination of diisocyanates with various resins, gas-generating agents and catalysts produces foams ranging from 1 to 60lb. per cu. ft. in weight, rigid enough to support heavy loads or flexible enough to serve as mattress filling and coat linings; they can be sprayed on walls, foamed *in situ* for filling cavities or formed into sheets and blocks for cutting or machinging. Other formulations based on diisocyanates yield synthetic rubbers with excellent abrasion resistance and corrosion and abrasion resistant coatings for car underbodies and concrete floors. Their diverse properties such as excellent dimensional stability, flexibility, insulation, adhesive powers, used with natural materials such as leather and as tanning agents, emphasise the versatility of polymers derived from isocyanates.

Polyurethanes

Polymers based on diisocyanates are polyurethanes formed by conversion of the isocyanate radical during polymerization into a carbamate grouping. Their name is derived from an old name for ethyl carbamate.

In 1937 a German chemist, Dr. Otto Bayer, of Farbenfabriken Bayer A.G., investigated diisocyanate-based polymers as a source of synthetic fibre to compare with or superior to nylon. Reacting diisocyanates with polymers he obtained products of no practical value, but in combination with polyesters synthetics were formed which proved useful as adhesives, others were light-weight, high-strength fibres—suitable for aircraft construction or for insulation purposes. Just before the World War II and during the war years, research on diisocyanates and diisocyanate reaction products was carried out in the U.S., but little attention was paid to urethanes until 1945, when German work on diisocyanate polymers was reported.

Foams

Of the polyurethanes, the most important are the foams, a one-inch layer of which has insulating value of 2½ inches of other materials. Foaming is accomplished by addition to polyesters of a small amount of water and an excess of diisocyanate, resulting in large volumes of CO_2 being produced. Polyurethanes can be foamed with fenetron (volatile hydrocarbons). Flexible foam is formed by the use of compounds like polypropylene gycol.

If the polymeric compounds reacted with diisocyanates have more than two reactive hydrogens per molecule, as in the case of an

alcohol containing three hydroxyl groups, the extra hydrogens lead to the formations of cross links between adjacent polymer molecules, resulting in a rigid foam.

Solid polyurethanes prepared from polyesters or related compounds and treated so that a controlled number of cross-links are introduced, have rubber-like properties. With more cross-links, polyurethanes become plastics that do not warp or swell and have high impact strength. Urethane resins, by virtue of their toughness and ability to adhere to surfaces, make remarkable adhesives and coatings.

Isocyanate Production Capacity

U.S.A.

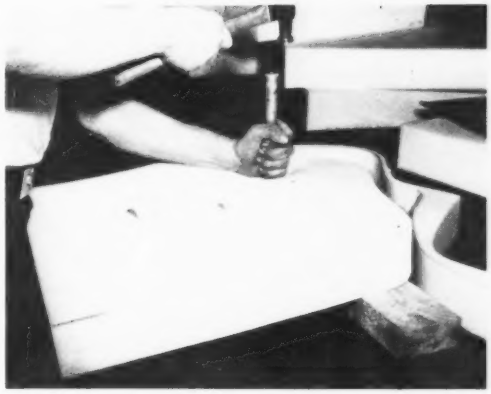
At the start of 1961 installed annual capacity for isocyanates totalled 58.5 million lb. represented by two producers, both of whom are continuing to expand capacity, while newcomers are also entering the field.

Mobay Chemical Company of Pittsburg, Pa. Having completed an expansion of the TDI plant at its new Martinsville, W-Va works in July 1960 whereby output capacity was raised from 18 million lb. to 25 million lb. a year, the company initiated a second project which was completed in May 1961. The additional facilities boost TDI capacity to 40 million lb. a year, yet the company announced a further expansion of 10 million lb. a year, due to be completed this autumn when Mobay's potential output will be 50 million lb. a year.

E.I. De Pont De Nemours and Company Inc. At Deepwater N.J. TDI production has recently been expanded to about 35 to 40 million lb. a year. Current output is about 25 million lb. a year.

Allied Chemical Corporation. Installed capacity of 8 million lb. TDI has been trebled and the company disposes of production facilities for up to 25 million lb. a year. The company's National Aniline Division is getting up a 15 million lb. a year plant to come into operation in 1962 in south California. Total capacity will thereby be raised to 40 million lb. a year.

Nopco Chemical Company. Construction began in March at Linden N.J. of a $7m. isocyanate plant. Principal product will be TDI to be used in urethane foam production at the company's North Arlington, N.J., plant. The Linden plant, which has an initial design capacity of 10 million lb. TDI a year, is designed and engineered by Bechtel Corporation and is due on stream by early 1962. Nopco is also constructing a new 4 million lb. a year polyurethane plant at Chattanooga, Tenn.



Urethane foam is being used as a tufting material in medium priced furniture. Here, holes are being die-cut in a 3½in. slab of foam. Upholstery thread is passed through the holes attaching buttons and fabrics in place

Carwin Company. A $1 million plant for the production of special isocyanates for high temperature foams has been brought on stream at Houston, Tex. The company has a similar facility at North Haven, Conn.

United Kingdom

Imperial Chemical Industries Ltd. is at present the main producer and its plant at Huddersfield, Yorks, which produces about 4.5 million lb. of isocyanates a year, has been in operation for a few years. The company has just completed at Fleetwood a new plant to produce isocyanates and phosgene. Commissioning trials are expected to continue until August, and capacity of the new plant is about 15,000 tons (30 million lb.) a year. Demand for polyurethane foams is increasing so rapidly in the U.K. (estimated at 12,000 tons this year) that it is expected that this facility will be expanded in the near future.

Du Pont U.K. Limited. At the end of June this company announced that it would construct a multi-million pound sterling plant to produce TDI under the trade name Hylene at Maydown, near Londonderry, Northern Ireland. This new facility is scheduled to be in operation by 1963. No details of plant capacity has yet been announced, but it is known that the plant will be large, especially as the company plans to export TDI.

France

Progil-Bayer-Ugine, jointly owned by Farbenfabriken Bayer AG. of West Germany, and Progil S.A. and Soc. d'Electro Chimie of France, will bring its first TDI production unit on stream at Pont-de-Calaix this summer. Also to be produced by this works will be polyethers and polyesters. Initial capacity of TDI will be 500 tonnes a month, reaching 1,000 tonnes a month by 1962. Raw materials (nitrogen, oxygen and chlorine) will be supplied from Progil and Ugine.

Soc. Toulousaine de Produits Chimiques (Tolochimie), recently formed by Rhône-Poulenc and Usines de Melle, is at present building a TDI unit at Toulouse.

West Germany

Farbenfabriken Bayer of West Germany is raising TDI production by 50% to keep pace with domestic and export requirements. No capacity has been revealed, but it is suggested that present capacity is not less than 15 million lb. and may be more.

Japan

Takeda Chemical Industries. The company is building a plant for production of TDI, using process know-how of Allied Chemical Corporation of New York. The agreement also provides for the design of a unit for waste acid stripping, purification of hydrogen and storage facilities for intermediates. The plant is scheduled to be completed in September and to have a capacity of 2,688,000lb. a month (122 tonnes).

Bridgestone Tire Company. Manufacture of TDI is on a small scale at present, but in view of Japan's growing requirements additional facilities are likely to be installed.

Foam Outlet for Isocyanates

U.S.A.

This year isocyanate capacity has more than doubled to 115 million lb. a year. Any surplus of supply or capacity in the next few months is likely to be short-lived in view of the rapidly rising demand for polyurethanes, the major consumer of isocyanates. By 1965 U.S. producers estimate that polyurethanes demand will rise to 300 to 350 million lb. a year. Flexible urethane foams have a sizeable market already, particularly in the car and building industries. This year some 16.1 million lb. of foam will be used in car seats in the U.S., a 50% increase since 1959. Since the foam can be made one half as dense as rubber latex, foam costs are lowered on a volume basis and the overall costs are being steadily reduced. By 1965 consumption of foam by the U.S. car industry is expected to be about 50 million a year.

Urethane foam used for foam core mattresses in 1960 accounted for only 2% of the $252 million mattress market, but the outlet is likely to grow rapidly as latex cores are priced out of the market. These urethane foams are also finding wide application as furniture upholstery, for which last year some 50 million lb. were used — a 25% increase over the 1959 total. By 1965 it is suggested some 190 million lb. will be used.

The application of urethane foam showing a steep rise is clothing interliners. In 1960 about 1.5 million lb. is estimated to have been used for this purpose whereas in 1965 demand is forecast at 7 million lb. Growing even faster is the use of foam for insulation purposes. By 1965 appliances are expected to account for 50 million lb., cold storage rooms for 16 million lb., pipe ducting for 10 million lb., transportation insulation and industrial storage bins for 8 to 10 million lb., frozen food display cases, etc., about 4 to 5 million lb. Building applications took an estimated 10 million lb. in 1960 and are now expected to require 100 million lb. by 1965. Boat builders alone, it is suggested, will use over 20 million lb. in 1965.

Another fast growing market for urethane is coatings, and in 1960 over 3.6 million lb. of urethane resin is estimated to have been for

U.S. Demand

	Polyurethanes		Isocyanates (equivalent)	
	1961	1965	1961	1965
	mill. lb.		mill. lb.	
Car Seats	16.1	50	5.4	16.9
Mattresses	50	190	16.9	63
Clothing Interliners	1.5	7	0.9	2.3
Insulation	—	50	—	16.9
Building Applications	10	100	3.3	33
Coatings	3.6	30	1.3	10
Others	—	160	—	33

this purpose. By 1965 consumption is likely to rise to about 30 million lb., representing about 10 million lb. of isocyanates.

Other, less determinate uses of polyurethane are urethane elastomer tyres, which have proved in trials to have a life of 100,000 miles, only their use is likely to be limited to specialised and heavy duty wear as the present-day trend in cars indicates a much shorter period of running. In view of the large potential size of the market the use of these materials is nevertheless being investigated by Du Pont. Based on the 1960 tyre production of 1,535 million lb. of synthetic and 724 million lb. of natural rubber, a change-over of only 5% to polyurethane would represent the use of 110 million lb. a year of polyurethane or some 34 million lb. of isocyanates.

The new elastomeric urethanes that can be processed like other plastics materials are also likely to make a strong impact, and the market potential is said to be 100 million lb. a year by 1965.

Cable jacketing could require by 1965 some 45 million lb. a year of urethanes.

Stretchable urethane fibres—Du Pont's "Lycra" and U.S. Rubber's "Vyrene"—could show notable expansion. Demand for these fibres is estimated at at least 15 million lb. a year.

U.S. Urethane Rubber Sales Forecast

1965	40.0 million lb.
1961	10.0 " "
1960	6.7 " "
1959	2.2 " "
1958	250,000 lb.

Based on Tariff Commission

U.K. Demand and W. Europe

By comparison with the U.S.A. the use of polyurethanes is still in its infancy in the U.K. and on the Continent, but the market development within the last nine months has been outstanding. Anticipated growth over the next four to five years is expected to raise demand for polyurethanes in the U.K. and the Common Market to over 111,000 tonnes by 1964 and to 160,000 tonnes by 1964, resulting in a demand for isocyanates of 36,000 tonnes by 1964 and 53,000 tonnes by 1965.

U.K. production of polyurethanes is estimated at 12,000 tons (4,000 tons TDI) for 1961. TDI requirements by foam producers are met by I.C.I. and imports from Du Pont and Allied Chemical, of the U.S., and Farbenfabriken Bayer AG., of West Germany.*

Isocyanate Plants Capacities

Producer	(Capacity) mill. lb. 1960	1961	1962
U.S.A.			
Mobay			
New Martinsville	25	40-50	50
W-Va	25	—	—
E.I. Du Pont de Nemours Inc.			
Deepwater, N.J.	25	35-40	40
Allied Chemical Corp.			
Moundsville W.Va.			
South California (no site selected)	—	—	15
Nopco Inc.			
Linden N.J.	—	—	10
Carwin Company			
North Haven, Conn.	0.5	0.5	0.5
Houston, Texas	0.5	0.5	0.5
Total Installed	**59.0**	**101-116**	**141**
	Capacity (Tonnes)		
France			
Progil-Bayer-Ugine			
Pont-de-Claix	—	1,700 (4mts.)	12,000
Soc. Toulousaine de Produits	—	—	5,000
West Germany			
Farbenfabriken Bayer AG.			
Leverkusen	5,000*	7,500*	10,000*
Italy			
Soc. Montecatini	—	—	5,000
Japan			
Takeda Chemical Inds.	—	365	1,460
	Tons		
U.K.			
Imperial Chemical Inds. Ltd.			
Wilton	2,000†	—	—
Fleetwood	—	5,000*	14,000*–15,000

	1960	1961	1962	1963
Maydown, Nr. Londonderry, N. Ireland	—	—	—	10,000*-15,000*

† Production * Estimated

* Victor Blagden Ltd., of London, supply isocyanates obtained from Carwin Company, U.S.A.

Japan

In the light of favourable marketing potentials for urethane foams, isocyanates capacity, as indicated above, is now being increased. MITI estimates the demand for polyurethane foam in 1962 at 15,000 tonnes, representing the use of about 5,000 tonnes of isocyanates, and in 1965 30,000 tons (10,000 tons TDI); a fourfold increase compared with this year's level of use.

In existence in Japan already are the following polyurethane manufacturers. Estimated isocyanates requirements are included.

	Tons		
	Capacity	Production	TDI Requirement
Bridgestone Tire ...	900	100	33
MTP Chemical ...	1,200	200	70
Toyo Rubber ...	2,000	120-130	40-45
Nisshin Spinning ...	60	—	20
Yokohama Rubber	600	Under construction	200

Mitsui Chemical Industries. A 36,000 tonnes a year polyurethane plant is to be built at the company's Ohmuda works. It is based on Du Pont techniques and is scheduled to be completed by May 1963. Polyether, one of the raw materials in polyurethane production, will be supplied from Mitsui's Nagoya plant using the company's own process. A number of companies have formulated plans for urethanes production, but as yet no details are known of their sources of isocyanates.

Light-weight urethane mattresses in 1960 accounted for 2% of the U.S. $252m. mattress market

Nippon Soda plans to use the Farbenfabriken Bayer process, while Kanto Denka and Mitsubishi Chemical Company will use domestic processes for polyurethane manufacture.

Bridgestone Tire, M.T.P. Chemical, Yokohama Rubber and Toyo Rubber are reported to have formed a combine to manufacture polyurethanes. Nisshin Spinning Company is basing production on its own foaming technique and Kurashiki Spinning Company will use I.C.I.'s technique and may use TDI imported from I.C.I. Daiwa Spinning Company will use a U.S. technique and will purchase TDI from Bridgestone Tire. Toyo Spinning Company and Kureha Spinning Company are also reported to be considering polyurethane foam manufacture, while Nichimen Jitsugyo, at present selling foam products, is contemplating manufacture, using Du Pont's technique, at its Arai site in Tokyo in a 300 million yen plant.

Mexico

A urethane foam plant already in production in Mexico is that of Cia Hulera El Palmar S.A., near Mexico City. Capacity is 50 tonnes a month. Due to start up in August is the 50-tonnes-a-month facility of the Mexican subsidiary of Dow Chemical Company, U.S.A. Planning a similar capacity urethane unit is General Popo, an associate of General Tire and Rubber Company, also of the U.S.A.

India

Demand for urethane foam in India is expected to be about 1,000 tonnes (requiring 300 tonnes TDI) in 1966. Projected capacity is 1,250 tonnes. It is believed, however, that polyurethane demand for this country has been underestimated.

Outlook

The key to the growth of isocyanates consumption are the polyurethane foams.

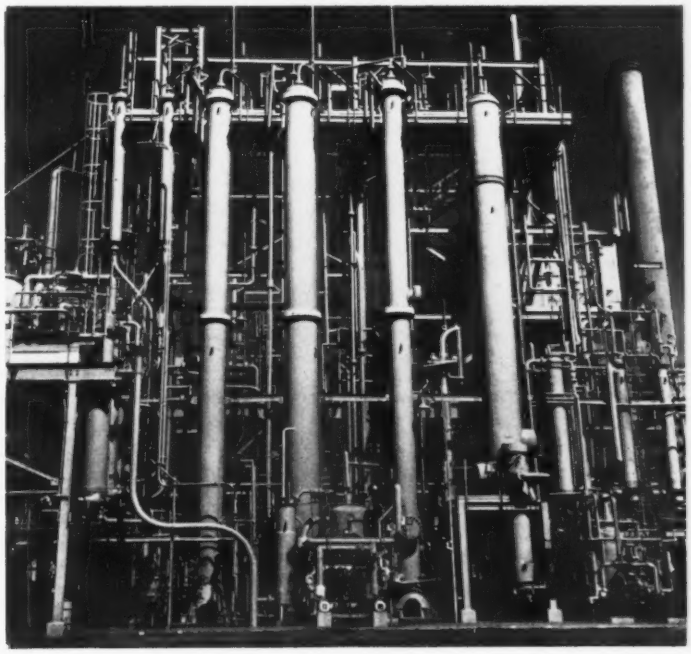
Flexible foams have already made a considerable impact on the household and car markets and whereas the use of rigid foams is only just starting, their potential is great, particularly if prices ease.

Japan's Production Capacity

Tons

Year	Soft Foam	Rigid Foam	Total	TDI Requirement
1959	1,100	—	1,100	400
1960	3,000	—	3,000	1,000
1961	7,200	800	8,000	2,700 —
1962	12,400	2,600	15,000	5,000
1963	22,000	8,000	30,000	10,000

The present high raw material cost—particularly of isocyanates—seem to be the main inhibiting factor. Comparing methane foam with fibrous insulation materials in the U.S.A. the difference in cost in favour of fibrous materials is currently 1.2 cents a cubic foot. If the price of the TDI were reduced from the present level of 70 cents per lb to 60 to 55 cents per lb. and polyol prices were reduced to 25 cents per lb., the cost difference would virtually vanish. Besides the cost factor, there are still technical problems to be resolved in the production of urethanes for special uses, especially urethane coatings, but in view of the rapid strides evident in this sector these are likely to be readily surmounted. On current indication world production capacity of isocyanates can be expected to expand during the next four or five years to over 140,000 tonnes, providing a substantial and growing outlet for primary and technical nitrogen.



Du Pont's isocyanates plant at Chamber Works, Deepwater Point, New Jersey, U.S.A.

World Nitrogen Production & Consumption at New Peak

WORLD production and consumption of nitrogen rose to a new peak in the fertilizer year which terminated on the 30 June 1961 and preliminary results indicate an increase in output of about 8% to 13.0 million tonnes N and in fertilizer and technical nitrogen use of about 7% to 12.8 million tonnes N. World stocks appear to have increased slightly compared with the position one year ago but in relation to increased level of production and use, the rise is insignificant and supply and demand are virtually in balance.

Uncertainty Among Producers

Whereas the steadily growing demand in the industrially advanced countries of the world, which account for 75% of demand and about 90% of production, provides the nitrogen industry's solid foundation, it nevertheless measures its prosperity in terms of world trade and prices and the latter, despite the increase in world trade—estimated to have totalled 2.7 million tonnes N in 1960-61—and the apparent balance between nitrogen supply and demand, fail to show any signs of regaining strength. The two dominant factors in present day world trade in nitrogenous fertilizers are shipments financed from U.S. Foreign Aid funds and the purchases by China, and both contribute in different ways to the prevailing uncertainty which is evident in particular among nitrogen producers in Western Europe.

China's purchases account for about one-seventh to one-eighth of total exports from Western Europe and her astute buying policy has to a large extent contributed to the decline in prices. Following the reduction of the volume of China's purchases in 1960-61, suppliers' attention is focused not only on the eventual size of Chinese demand in 1961-62 but equally on the timing of purchases and, last but not least, whether a political settlement with Japan will direct the greater part of orders to China's traditional fertilizer supplier.

"Buy American" Policy*

The implications of the "Buy American" policy in respect of fertilizers purchased with aid funds from ICA or its successor agency in Washington, go deeper, and as many aspects have not so far been clarified, its impact on the major suppliers in Western Europe and Japan which are primarily affected, is all the more unsettling. The principal recipients of "aid fertilizers" are South Korea and Vietnam, and Turkey, Pakistan and India are likely to become more prominent this year. If fertilizer supplies of actual or qualified U.S. origin only are to be supplied, Japanese exporters of ammonium sulphate and urea would be severely hit† and forced to seek outlets elsewhere, notably in South America, the Indian sub-continent and possibly also China, which would have direct repercussions on West European exporters, quite apart from the direct reduction of their markets, notably on the Indian sub-continent, as the result of U.S. aid supplies.

U.S. Nitrogen Expansion

A Japanese mission to Washington has recently put forward the industry's case for a more liberal interpretation of ICA purchasing policy. Also most of the receiving countries favour non-U.S. suppliers because of their substantially lower prices. At present U.S. nitrogen industry is only just able to meet rising domestic demand and of the two materials principally in demand in aid receiving countries ammonium sulphate is consistently and urea intermittently in short supply in the U.S.A. Under these conditions the Administra-

* "Limited World Wide Sources" † In 1960-61 Japan exported 100,000 tonnes N under ICA funds

tion may consider some modification of the restrictive measures applying to the 19 countries which are no longer considered to be in need of the impetus of foreign aid purchases. The U.S. nitrogen industry is, however, expanding at an exceptionally fast rate and by the end of 1962 new ammonia capacity of at least 800,000 tons NH_3 is due on stream, which will result in temporary oversupply in respect of which the industry may demand an outlet in the form of aid-fertilizer deliveries.

Under these circumstances the apprehensions of the major N fertilizer producers outside the U.S.A. seem to be justified and despite the reasonable expectation of an increase in world demand in 1961-2 of at least 8% and probably as much as 10%, world prices will remain under pressure and one year hence may stand lower than to-day. Improvements in processing technique and the increasing use of cheaper hydrogen sources by the major producers can, however, be expected to enable them to maintain their profitability.

U.S.A.

Ammonia production reached a new peak in March when it rose to 463,302 short tons NH_3. This level was virtually maintained in April (460,866 short tons) and output in the first four months of 1961, which represented an annual rate of 5.2 million short tons NH_3, was 7.4% higher than in the same period of 1960. Ammonium sulphate remained in short supply, production falling 153,000 short tons (24.3%) below that in January to April 1960. Output of ammonium nitrates in January to April 1961 was 2% greater than in the preceding year but demand, which had been strong and was expected to boom, is reported to have tailed off after April. Urea demand has improved notably in the late spring and in June widespread shortages of supply were reported.

Production
Short tons

	January to April 1961	January to April 1960
Anhydrous ammonia ...	1,736,537	1,617,353
Ammonium nitrates (100% NH_4NO_3) ...	1,106,253	1,085,064
Ammonium sulphate :		
synthetic	280,313	335,793
by-product	177,666	269,140
Nitrogen solutions (100% N)	339,897	311,364
Nitric acid (100% HNO_3)	1,130,760	1,748,650

Exceptionally strong were sales of feed grade material following a rise in prices of organic feeding stuff.

New Plants

Coastal Chemical Corporation has initiated a $4½ million project whereby, utilising available spare synthesis gas compression capacity, installed ammonia capacity at Pascagoula of 70,000 s. tons NH_3 will be doubled. With the facilities of its parent company—Mississippi Chemical Corporation—the group will dispose of 250,000 s. tons NH_3 by autumn 1962. The additional ammonia output will be used for ammonium phosphate production at Pascagoula, some by Mississippi Chemical, and the balance will be sold for direct application.

International Minerals and Chemical Corporation is extending its plant facilities at Bonnie, Fla., by the addition of a $3.8 million plant for the manufacture of 100,000 s. tons a year diammonium phosphate (18-46-0); the plant is to come on stream in October 1961.

American Cyanamid Company plans a $3 million expansion of its ammonia plant at Fortier, La., plant which when completed, before the end of 1962, is expected to raise installed ammonia capacity of 50,000 s. tons N by 40%.

Southern Nitrogen Company is increasing ammonia capacity at Savannah, Georgia, by 50% to 150,000 s. tons NH_3.

Escambia Chemical Company is raising installed ammonia capacity at Pensacola by 15% to 230 s. tons NH_3 a day.

North-West Co-operative Mills Inc., of St. Paul, Minn., is building a $4 million plant at Pine Bend, Minn., due on stream in April, 1962, for the manufacture of 100,000 s. tons a year of ammonium phosphate.

Monsanto Chemical Company has started production of a high-analysis granular ammonium nitrate phosphate fertilizer "Nutrium" (29-14-0) which is being sold in bulk and 80lb. sacks to meet specific soil requirements in the Mid-West and South-Western States.

Spencer Chemical Company will bring on stream in 1962 a high-analysis (30-10-0) complex fertilizer plant with an annual capacity of 50,000 s. tons a year.

Consumer Co-operative Association expects to start production at its 150 s. tons-a-day anhydrous ammonia fertilizer plant at Hastings, Neb., by November of this year. Construction of the $8 million project, for which Chemical Construction Company is the main contractor, started in April.

Hercules Powder Company has started to build at its plant in Louisiana, Mo., an ammonium nitrate solution unit with an annual capacity of 50,000 s. tons as well as a second unit for the manufacture of 40,000 s. tons a year ammoniated ammonium nitrate. The new units are to be completed by the summer of 1962.

Dow-Badische, a joint subsidiary of Dow Chemical Company and BASF of Ludwigshafen is building a 40 million lb. a year caprolactam (nylon - 6 monomer) plant at Freeport, Texas. Up to 80,000 short tons by-product ammonium sulphate will be produced.

WESTERN EUROPE

Throughout Western Europe synthetic nitrogen production reached peak levels in the spring and domestic and export demand was heavy. By now practically all the accumulation of orders appears to have been cleared and producers are starting to make up their programme for the autumn. In respect of export deliveries there is much uncertainty but expanding domestic demand, especially in technical uses, is a stabilising factor.

United Kingdom

Production of synthetic nitrogen fertilizers in the first quarter of 1961 totalled 115,800 tons N, an increase of 8,500 tons N (8%) compared with the first quarter of 1960. Deliveries to the home market, which included imported material, totalled 157,000 tons N in the period January-March 1961 and 344,600 tons N in the three-quarters of the fertilizer year 1960-61, compared with 313,400 tons N in the same period of the fertilizer year 1959-60, an increase of 10%.

I.C.I. Wilton Division has commissioned British Oxygen Company to build at a cost of £500,000 a tonnage nitrogen plant with an hourly capacity of 5,000 cu. metres, corresponding to about 140 tonnes N per day. The unit, which will augment nitrogen supplies at Wilton by 50%, is due on stream by mid-1962.

Belgium

Production of synthetic nitrogen during the first half of 1961 totalled 135,000 tonnes N, compared with 163,897 tonnes N in the same period of 1960, a reduction of 17.5%. Following the closure of the Tilleur works of Soc. Ammoniaque et Synthetiques Derivés, which did not resume operations after the widespread strikes in January, the number of synthetic nitrogen plants was reduced to seven. Fisons Union Chimique Belge at Zandvoorde is bringing on stream in July its new lime ammonium nitrate plant, which has a capacity of 115,000 tonnes of 20.5% N and higher strength product. The raw materials requirements are being supplied from the nearby U.C.B. ammonia plant. Construction of the compound fertilizer plant—the second stage of the Fison/U.C.B. programme—is progressing normally and the plant is due on stream early in 1962.

In a new decree due to come into force on the 1 October 1961 revising the specifications of what may be sold as "ammonium nitrate," it is stipulated that the minimum content of combined ammoniacal and nitrate nitrogen will be 22%. A clause provides, however, for the continuation of sales of lower strength—down to 15.5% N—material up to 1 May 1962, provided that the product was in the retail trade on 1 October 1961.

France

During the first five months of this year production of ammonia was at an annual rate of 833,000 tonnes N. During April and May the level of output receded 4.4% from the peak attained in March, but at 69,900 tonnes N output was nevertheless 24.5% above the monthly level of the second quarter of 1960. Production of fertilizer nitrogen during the period January to May totalled 292,370 tonnes N, an increase of about 50,000 tonnes N (20.6%) over output in the same period of 1960, represented mainly by ammonium nitrates (+21.4%), ammonium sulphate (+18%) and urea (+39.2%). Technical nitrogen production

and use continues to rise steeply and in April totalled 10,640 tonnes N.

The Soc. Chimique de la Grand Paroisse plans to build a major ammonia/fertilizer plant at Donges (Loire-Atlantique), which will be based partly on refinery gas and partly on natural gas. The company has ceded its rights in the 30,000 tonnes N a year plant at Grand Quevilly to Cie de Saint-Gobain.

West Germany

Synthetic ammonia production during the first four months of 1961 totalled 441,805 tonnes N, an increase of almost 40,000 tonnes N (9.8%) compared with the same period in 1960, and bringing output during the 10 months period of the fertilizer year 1960-61 to 1,079,575 tonnes N. Fertilizer nitrogen production in the year 1960-61 to end April totalled 979,522 tonnes N, including 198,756 tonnes N in March and April, and was about 110,000 tonnes N (12.8%) greater than in the corresponding period of the year 1959-60. Domestic deliveries reached a peak of 64,038 tonnes N in March and for the 10 months ending April totalled 569,049 tonnes N, 1.5% more than in the period July 1959 to April 1960. Nitrogen fertilizer exports also reached a peak in March of 59,786 tonnes N, but results to end April of 416,662 tonnes N were 1% below those for the same period in the fertilizer year 1959-60. Exports were represented by 390,022 tonnes N in straight fertilizer and 26,640 tonnes N in complexes. Fertilizer stocks at the end of April totalled 170,733 tonnes N, an increase of about 62,000 tonnes N compared with the stocks in April 1960.

Badische-Anilin und Soda-Fabrik has developed a new nitrogenous fertilizer—intended for horticultural use—under the name Floranid. It contains 28% N of which 90% is a reaction compound of crotonaldehyde and urea, and 10% nitrate nitrogen, and is claimed to remain active for unusually long periods.

Greece

An ammonium phosphate plant to manufacture 250,000 tonnes a year of 16-20-0 is to be built under the auspices of OWA, the Greek Industrial Development Corporation, which is to establish a company in which 60% of the share capital will be held by Greek financial interests and 40% by foreign interests, including the Freeport Sulphur Co. The total cost of the project will be $23 million, of which $18 million will be required for imported plant. The plant is due on stream in 1963, when domestic consumption of this complex fertilizer is foreseen at 130,000 tonnes a year and until 1970 when domestic needs are expected to correspond to the above plant capacity a proportion of the output will have to be exported.

Italy

Caprolactam is to be manufactured by Sicedison in a plant now under construction at Porto Marghera.

Portugal

Ammoniaco Portugues produced in 1960 some 31,000 tonnes ammonium sulphate, 4% more than in 1959. Exports contracts concluded in 1960, a proportion of which remain to be executed, totalled 24,000 tonnes ammonium sulphate.

COMMUNIST COUNTRIES

Poland

In 1960 production of nitrogenous fertilizers totalled 270,000 tonnes N, 5.6% (14,300 tonnes) more than in 1959. Production is to be raised progressively to 464,000 tonnes N by 1965 and 810,000 tonnes N by 1970. The key project is Pulawy which, based on natural gas, will have an initial fertilizer output of 330,000 tonnes N by 1966.

Under the current five-year plan Poland plans to build five urea plants, of which the first has been ordered from Power Gas Corporation of Stockton-on-Tees on a deferred payment basis. With a daily capacity of 500 tonnes product, mostly fertilizer grade and small quantity of feed grade, it will employ the Toyo Koatsu process.

At Tarnow, a caprolactam plant with an annual capacity of 8,000 tonnes is projected.

Yugoslavia

Under a barter agreement with Hungary, Yugoslavia is to receive before the end of this year 30,000 tonnes ammonium nitrates. This

follows an announcement that Yugoslavia will purchase further quantities of nitrogenous fertilizers from East Germany over a five-year period until 1965.

AFRICA AND NEAR EAST

Union of South Africa

Serious breakdowns in the new ammonia and urea plants of African Explosives and Chemical Industries Limited at Modderfontein have prevented these plants reaching design capacity by the end of this year. Now it is hoped that 75% of the capacity will be reached which, in respect of the urea plant, would represent 77,500 s. tons.

Mali

Under a recent trade agreement, the U.S.S.R. will supply nitrogenous fertilizers to Mali during the current year.

Egypt

At a time when the ammonium sulphate project at Suez, where annual production of some 250,000 tonnes product a year is foreseen, is being delayed and is now not expected to come on stream until 1962, the U.A.R. Development Organisation is studying the possibility of producing ammonium sulphate on the basis of recently discovered gypsum deposits on the Sinai peninsula.

Kuwait

A petrochemical/nitrogenous fertilizer plant is projected at Kuwait by a consortium of Kuwaiti interests (20%), the Government (40%) and Oronzio de Nora of Milan (40%), which have formed the Kuwait Petrochemical Company. The first stage of the project includes an urea plant with a reported annual capacity of 90,000 tonnes product. Almost its entire output is to be exported, in which the Italian company is reported to have agreed to assist.

MIDDLE AND FAR EAST

India

Plans to purchase 250,000 tons ammonium sulphate of U.S. origin, and to be shipped in U.S. vessels, are reported to be under discussion between the Indian Government and the Development Loan Fund.

In 1961-62 nitrogen fertilizer production in India is expected to reach 180,000 tons N but, despite the higher domestic supplies, the level of imports is likely to be maintained at about 130,000 tons N. The production target of India's third five-year plan of 1 million tons N by 1965-66 is being reviewed and may be, it is reported, increased by 5 to 10%. At the same time India's adverse payment position is jeopardising the timely execution of projects foreseen under the existing plan.

Fertilizers and Chemicals (Travancore) Limited has started production of ammonium phosphate—believed to be 18-46-0—at an annual rate of 16,500 tonnes which is to be raised to 33,000 tonnes product a year by the end of this year. The company's ultimate production target is 135,000 tonnes a year.

Pakistan

ICA financed procurements have called for three tenders to be submitted by 23 August 1961 totalling 62,000 tonnes urea; these are for shipment between 15 October 1961 and 15 April 1962 to Chalna/Chittagong. To date, under the current procurement programme, shipments of urea to the value of $4.61 million and of urea and ammonium sulphate valued at $2.3 million, to be made between 31 March 1961 and 15 May 1962, have been authorised. In March Japan sold to Pakistan 5,000 tonnes urea at $98 c. and f. Karachi.

Japan

Nitrogen fertilizer production during the three months February to April 1961 totalled 252,000 tonnes N, not including calcium cyanamide production, which amounted to 19,400 tonnes N. Output of the latter has increased progressively and in April rose to a peak of 42,222 tonnes product. Deliveries to home and export markets totalled 322,000 tonnes N, resulting in a reduction of stocks to 90,000 tonnes N at the end of April. Heavy deliveries of urea, especially in March—when they totalled 114,374 tonnes—have reduced stocks to 71,100 tonnes product. Recent export sales concluded for Japanese urea include 8,000 tonnes to the Sudan, 10,200 tonnes to Peru,

7,688 tonnes to Australia, 2,850 tonnes to the Philippines, 150 tonnes to Guatemala and 530 tonnes to Mexico. The principal suppliers are Mitsui Bussan, Mitsubishi Shoji, Sumitomo Shoji, Showa Denko, Kyowa Fermentation and Nissan Chemical Company. Production in Japan during the fertilizer year ending 31 July 1961 is expected to be 1.06 million tonnes N. Domestic demand is expected to rise 7.3% to 759,000 tonnes N while exports of 321,000 tonnes N are expected to be 4% lower than in the preceding year.

South Korea

Tenders to be contracted by 31 December 1961 for shipment before 28 February 1962 have been issued by ICA in respect of urea, ammonium sulphate and ammonium nitrate to the value of $11,188,000, to be supplied by "limited world-wide sources."

Vietnam

ICA have issued procurement authorisations for nitrogenous fertilizers valued at $1.8 million for delivery by December 1961 from "limited world-wide sources."

Philippines

The Agricultural Credit and Co-operative Financing Administration in July issued a tender for 10,000 tonnes ammonium sulphate, 10,000 tonnes of 12-24-12 and 5,000 tonnes of 12-12-12 complex fertilizers. This tender will account for about 9% of the Philippines nitrogen fertilizer consumption in 1961-2.

Australia

ICIANZ has started construction at Botany, New South Wales, of a nitrogen fertilizer plant with annual production capacity of 63,000 tonnes, including urea, ammonium nitrate and complex fertilizers*.

Gas and Fuel Corporation of Melbourne plans to expand its brown coal gasification plant at Morwell, Vic. Lurgi AG. of Frankfurt is expected to be responsible for plant construction, and some of the additional gas will be used in N fertilizer manufacture.

CENTRAL AND SOUTH AMERICA

Cuba and Dominica have been added as from 1 April 1961 to the ICA list of countries excluded as eligible sources of supply of ICA financed purchases.

Colombia

Construction is to start in July at Cartagena of the 325 tonnes a day NH_3 ammonia plant of Amoniaco del Caribe, a subsidiary of Intercol†. Including provision for the manufacture of nitric acid, ammonium nitrates and complexes, this will become the country's second major nitrogen fertilizer plant and bring production capacity to 92,500 tonnes N annually, of which about 31,000 tonnes a year N is destined for export to Central America.

EXPORT PRICES

Ammonium sulphate

World market prices range from $26 to $32 per tonne in bulk f.o.b. Western Europe. U.S. material, if available, is offered at domestic prices and export prices from Japan remain at $39.50 to $41.80 per tonne in bulk f.o.b. Reflecting the weaker tone of markets, the bulk of current quotations by Western European suppliers tends to be based on $28 per tonne f.o.b. in bulk and range from $31 to $35 per tonne f.o.b. in bags.

Under the tender of the Pakistan Government in respect of ICA procurements for 15,000 tons ammonium sulphate f.o.b. / f.a.s. quotation ranged from $37.33 to $52.89, c. & f. quotations ranged from $69.93 to $104.68 in U.S. flag vesels, and $54.22 to $75.09 in foreign flag vessels. With the exception of C.U.F. of Lisbon all supplies originate from the U.S.A., the lowest quotations being submited by Rohm and Haas, in respect of what is believed to be byproduct material.

Ammonium Nitrate

Current quotations for ammonium nitrate (34% N) range from $57 to $63 per tonne f.o.b. Western Europe and up to $86 per tonne f.o.b. Japan. Supplies from Communist countries,

* See Page 30

† See Page 33

notably U.S.S.R., Bulgaria and Poland, are being quoted in Western Europe at prices corresponding to the lower level of the bracket.

Lime Ammonium Nitrate

The level of export prices of lime ammonium nitrate (20.5% N) is no longer consistently below that of ammonium sulphate and, in particular, offers to Spain at $31 to $33.50 per tonne f.o.b. in bulk were $1 to $1.50 above corresponding ammonium sulphate quotations. The bulk of export quotations is, however, still up to $1.50 below those for ammonium sulphate.

Calcium Nitrate

Current quotations range from $37 to $37.50 per tonne f.o.b.

Urea

Pressure of supplies continues to depress world prices of urea. In Europe quotations as low as $70 to $72 per tonne f.o.b. in bags are reported, although mostly they are in the range of $75 to $78. The bulk of recent exports from Japan is reported at $88 to $94 per tonne f.o.b. in bags but ranging quotations as low as $76 are also in evidence. Sales of U.S. urea in export markets range from $100 to $108 per tonne f.o.b. in bags, corresponding to domestic price levels.

Ammonium Phosphate

Recent sales of 16-20 from Japan are reported at $66 to $77 per tonne f.o.b.

DOMESTIC PRICES

Reduction in the listed prices for deliveries to the home market have been made in several European countries, notably the U.K. In the U.S.A. domestic prices have, with the exception of urea, remained substantially unchanged.

U.S.A.

The difference between the price levels for anhydrous ammonia on the West Coast and the rest of the U.S.A. is narrowing. Recently Shell Chemical Company raised its price in California from $66 to $74 per short ton *ex*-works, which has been followed by other suppliers. The price ruling on the East Coast, the Southern, Mid-Western and North Central States remains $92 per short ton *ex*-works.

Urea

There is still a considerable divergence of prices quoted by individual producers. W. R. Grace increased prices with effect from 1 July by $2 for fertilizer grade and $3 for feed and industrial grades, and at the same time established prices on a "delivered" basis as follows :—

Per short ton				
Fertilizer grade (45%-46% N)		Feed grade 42% N		Industrial grade 46% N
Bagged	Bulk	Bagged	Bulk	Bagged
$98	$92	$103	$99	$110.50

Allied Chemical Company established prices in buyer's option f.o.b. plant or "freight allowed," i.e. delivered. For the fertilizer grade (45% N) in bulk the list price is $86.50 per short ton f.o.b. plant or $90 delivered. For bagged material in truck or carloads it is $92.50 f.o.b. plant and $96 delivered.

Other suppliers list their prices as shown in the following table:—

	per short ton			
Spencer	f.o.b.	50 tons	30 tons	less than 30 tons
During September	$87.25	$89.25	$90.75	$92.00
October/December	$91.25	$93.25	$94.75	$96.00
January/July	$95.25	$97.25	$98.75	$100.00
Deere				
During September	$87.00	$89.50	$90.50	$92.00
October/December	$91.00	$93.50	$94.50	$96.00
January	$95.00	$97.50	$98.50	$100.00

Delivered prices +$3.50 per s. ton

* See Current Events

U.S. Prices

Ammonium sulphate	
Coke oven	$32 per short ton, in bulk, f.o.b. works
Synthetic	$35 per short ton, in bulk, f.o.b. works
Ammonium nitrate	
Fertilizer grade (33.5% N)	$64-$67 per short ton, in bulk, f.o.b. works
Fertilizer grade (20.5% N)	$48 per short ton in bags ex-works
Nitrogen solutions	
Ammonia/ammonium nitrate	$150 per short ton (100% N) tank cars ex-works
Ammonia/ammonium nitrate/urea	$158 per short ton (100% N) tank cars ex-works
Anhydrous ammonia	
Fertilizer grade	$92 per short ton, tank cars, ex-works
Refrigeration grade	$94.50 per short ton, tank cars, ex-works

In this respect it is significant that Allied Chemical Company has decided not to grant any seasonal discounts in future, but no decision has yet been reached in this respect by the majority of suppliers. It is expected that eventually the unit-N cost in urea and ammonium nitrate will become identical.

United Kingdom

The Board of Trade is considering an application for the imposition of an anti-dumping duty on ammonium sulphate—other than analytical and reagent grades—imported from East Germany. During the period July 1960 to May 1961 these totalled 15,377 tons product.

Substantial reductions of listed prices of nitrogenous fertilizers have been announced by all suppliers for the fertilizer year 1961-62. I.C.I. has reduced prices of complex fertilizers —C.C.F. and high N.C.F.—by £1 per ton, of nitrochalk "21" by £1 1s., and of ammonium sulphate by 12s. 6d. Fisons Limited reduced its high analysis compounds (41 range) by 7s. 6d. per ton, and Shell Chemical Company reduced its complex fertilizers by £1 3s. 6d. to £1 10s. per ton.

The new listings and the new subsidy rates which for nitrogen are reduced from 9s. to 8s. 4d. per long ton unit N are as follows :—

d/d farmer's nearest railway station

	per ton	subsidy
	£ s. d.	£ s. d.
Ammonium sulphate	18 19 6	8 15 0
Nitrochalk 15.5% N	17 9 0	6 9 2
,, 20% N	22 10 0	8 15 0
Nitra Shell 23% N	24 13 0	8 11 8
Shell No. 1. (17:11:22)	36 3 0	8 4 1
Shell No. 2 (21:14:14)	39 18 0	13 6 10
Fisons 41 (10:10:18)	24 17 6	7 9 2
Nitrate of soda 16% N	21 18 0	6 13 4

Japan

Wholesalers' maximum standard prices for nitrogenous fertilizers delivered buyers' nearest railway station are as follows:—

Ammonium sulphate	Yen 772.40 per 40kg. net in straw bags
Urea	Yen 748.04 per 20kg. net in vinyl bags

(Yen 1,009=£1)

Rhodesia

Prices of nine of 12 compound fertilizers now on sale in Rhodesia were increased in April by 3s. to 18s. D compound (8:16:8) is now £27 6s. 6d. per short ton and E compound (8:0:16) £29 2s. 6d. At the same time farmers stipulating delivery in jute sacks—instead of paper bags—will have to pay £1 2s. 0d. more compared with last season's differential of 10s.

Belgium (B.Frs. per 100 Kgs. in bulk)

	Ammonium Nitrate	Ammonium Sulphate		Perlamide	Cyanamide	
	22.5% N	20.5% N	20% N	18% N	18% N	22% N
May	255	238	230	347	326	379
June	257	238	230	347	326	379
July	257	238	230	—	—	—
August	257	238	230	—	—	—

France

(New Francs per 100 kg. in 20 tonne lots)

	JUNE		JULY		AUGUST	
	Without taxes	With taxes	Without taxes	With taxes	Without taxes	With taxes
Ammonium sulphate						
20% N	21.46	23.84	21.70	24.11	21.94	24.38
20.60% N	22.17	24.63	22.41	24.90	22.65	25.17
21% N	22.64	25.16	22.88	25.42	23.12	25.69
Urea (prills)						
45% N	45.83	50.92	46.32	57.47	46.82	52.02
46% N	46.85	52.06	47.35	52.61	47.86	53.18
Lime ammonium nitrate (ammonitrate)						
20.50% N	20.88	23.20	21.10	23.44	21.33	23.70
27.50% N	26.81	29.79	27.10	30.11	27.39	30.43
33.50% N	31.14	34.60	31.47	34.97	31.81	35.34
34% N	31.60	35.11	31.94	35.49	32.28	35.87
34.50% N	32.07	35.63	32.41	36.01	32.76	36.40
Calcium nitrate						
15% N	19.97	22.19	20.19	22.43	20.40	22.67
15.50% N	20.63	22.92	20.86	23.18	21.08	23.42
Calcium magnesium nitrate						
13% N	18.90	21.00	19.11	21.23	19.31	21.46
Ammonium nitrate						
33.50% N	30.24	33.60	30.56	33.96	30.89	34.32
34.50% N	31.14	34.60	31.47	34.97	31.81	35.34
34.90% N	31.50	35.00	31.83	35.37	32.18	35.76
Sodium nitrate						
16% N	—	—	25.31	28.12	25.59	28.43

West Germany

(per tonne N in bulk)

	June	July	August	Sept./Oct.
Ammonium sulphate nitrate (26% N)	DM 1,150	DM 1,045	DM 1,070	DM 1,090
Ammonium sulphate (21% N)	DM 1,140	DM 1,035	DM 1,060	DM 1,080
Calcium ammonium nitrate (20.5% N)	DM 1,175	DM 1,010	DM 1,030	DM 1,050
Urea (46% N)	DM 1,090	DM 985	DM 1,010	DM 1,030
Calcium nitrate (15.5% N)	DM 1,330	DM 1,230	DM 1,250	DM 1,270

Spain

The current domestic prices quoted by leading producers are as follows :—

Ammonium sulphate ... Pesetas 2982-3050 per tonne ex-works in bags ($49.50-$50.60)

Lime ammonium nitrate (20.5% N) ... Pesetas 3295-3337 per tonne ex-works in bags ($54.65-$55.30)

Farmers' prices are augmented by transport charges and retailers' margins.

Freights

Strong Seasonal Activity in Outward Freight Markets from Europe

OUTWARD freight markets from Europe to South-East Asia and the Far East have shown strong seasonal activity and as in the last three years a sharp increase in shipments of nitrogenous fertilizers has coincided with a heavy volume of charters by China to cover her large annual phosphate purchases from Morocco such an upsurge in demand leads always to a tussle between cargo interests and shipowners, the latter seeking, and usually securing, higher freights while the pressure is strong. Last year, after some weeks of bargaining, the Chinese covered their first ship from Casablanca (f.i.o.) at the end of April at 50s. 0d., conceded an average of 60s. 0d. during May and finished their programme in June at 57s. 6d. During this period a heavy tonnage of ammonium sulphate and urea sought cargo space to Indonesia, and although concessions of a few shillings a ton had to be made, the shipping requirements from North-West Europe were covered at about an average of 58s. for ammonium sulphate in bags, with the usual premium for lighter-density urea. From Adriatic loading ports to Indonesia 52s. 6d. a ton satisfied shipowners.

This year by mid-April it was evident from brokers' circulars detailing tonnage needs, that many ships were granted to go out East but for several weeks the small advances offered to shipowners over original freight quotations failed to meet their rising demands. Finally, one broker who for almost two months had been seeking a 10,000-tonner for a full cargo of ammonium sulphate from Antwerp to Sourabaya, and offering consistently 52s. 6d., succeeded in chartering a vessel, allegedly at 70s.! This was followed by a number of publicly reported "fixtures" at from 89s. 6d. to 96s. 0d. a ton. In sympathy, the rate to main Indian ports from Antwerp/Hamburg advanced to 75s. 0d., a gain of over 50% on that current in the Spring of 1959. Early in June the Chinese secured their first ship from Casablanca, at 70s. 0d. a ton. Their success in getting cover at some 5s. a ton less than had been hoped for by some shipowners may be attributable to the fact that it was a Moroccan vessel owned by a company closely associated with the Government and the O.C.P. and to the sellers of the mineral.

These "peak" rates were undoubtedly exaggerated, and they have since fallen somewhat, as indicated below but it is clear that they were caused by the charterers holding off too long and finally having to charter, cost what it may. While it is easy to be wise after the event, it would seem that if the horizons of the freight market were wider and its links with world commerce and industry closer, this situation might have been avoided. For many months now the Japanese have been taking up a very large volume of shipping, at the same time as the Russians, and, of course, the Chinese, since disclosure of the serious internal food situation. Almost all of the ships taken have been conventional tramp sizes—between 10,000 and 14,000 tons cargo— and at present there is no oversupply of such vessels with the result that the kind of "squeeze" which occurred in May could happen again.

In order to cover their commitments to the area the Indonesian Liner Conference has had to charter outside tramp ships at high rates of hire. Liner shipments included 8,000 tons of urea from Heroen, which had been seeking space on the tramp market for some time. Tariff rates from U.K./Continent to Indonesia, recently increased to 88s. 0d. a ton for ammonium sulphate and ammonium nitrates and 99s. 6d. for urea are at present fractionally below tramp rates—if allowance of some 10s. a ton is made for cargo-handling, stowage and landing costs.

The following statistics of fertilizer freights are based mainly on known charterings, but when no recent information is available "notional" rates are quoted, based on bookings for other commodities on similar routes.

N.B. All figures are per long ton, net f.i.o., i.e. exclusive of costs of loading and discharging.

Fertilizer Freights*

Importing Area	Shipment from	JUNE FREIGHTS 1961	1960	1959
South China	N.W. Europe	75s. 0d.	62s. 6d.	59s. 0d.
,,	Adriatic	70s. 0d.	60s. 0d.	54s. 0d.
India/Pakistan	Adriatic	65s. 0d.	46s. 0d.	41s. 0d.
,,	N.W. Europe	70s. 0d.	50s. 0d.	45s. 0d.
,,	U.S. Gulf	$10.75	$9.20	$8.50
,,	British Columbia	$10.25	$7.50	$7.45
India	Chile	105s. 0d.	100s. 0d.	95s. 0d.
Taiwan	U.S. Gulf	$11.00	$8.00	$8.00
,,	N. Pacific	$9.25	$6.25	$6.00
Philippines	N. Atlantic	$10.55	$7.85	$7.00
,,	N.W. Europe	$11.20	$8.10	$7.65
Greece	N.W. Europe	32s. 6d.	35s. 6d.	33s. 6d.
,,	U.S. Gulf	$7.25	$6.50	$6.05
Egypt	N.W. Europe	36s. 0d.	37s. 6d.	36s. 6d.
,,	Adriatic	20s. 9d.	23s. 0d.	18s. 6d.
Brazil	U.S. Gulf	$7.50	$5.50	$4.75
South Africa	N.W. Europe	37s. 3d.	36s. 3d.	38s. 3d.
Peru	Japan	$7.25	$5.75	$5.60

* Per long ton net, exclusive of loading and discharging costs.

AIKMAN [LONDON] LTD.

Directors:
BARRY T. AIKMAN, D.F.C
HAROLD C. RATTLE

Consultant:
L. TERTIUS AIKMAN

Cables: "AIKMAN LONDON, S.W.3."
Telegraphic Address: " AIKMAN LONDON TELEX "
Telephone No.: KNIGHTSBRIDGE 8731
Telex No.: LONDON 25443

49, EGERTON GARDENS,
LONDON, S.W.3.

July 1961.

Half-yearly Report on the Nitrogen Industry

(all tons are of 1,000 kilos unless otherwise specified)

Little revision in our estimates of nitrogen production and consumption has been necessary since our annual report issued in November 1960 but our estimates for the fertilizer year 1961-62 have been added and show a world increase both in production and consumption of 7% over 1960-61.

There is still no sign of any improvement in nitrogen export prices and although, as an example, ammonium sulphate averages £10 per tonne in bulk f.o.b. and trimmed, some sales, notably to China, have been below this figure. It is surprising that with world production and consumption so nearly balanced that there should not have been a check of the decline in prices and this trend can mostly be accounted for from nervousness when stocks begin to accumulate above producers' ideas of a satisfactory level. Stocks, however, are now satisfactory and there will be no surplus at the end of the 1960-61 fertilizer year above the normal carryover of stock into the next year.

During the current fertilizer year the Chinese were late in coming into the market and did not place orders until the end of November 1960. It is probably for this reason the Chinese buyers were able to purchase at their lowest prices ever, as for example, ammonium sulphate at £11 per ton in bags f.o.b. and calcium ammonium nitrate at £10 6s. 0d. Total purchases for the 1960-61 season only amounted to 200,000 tons of pure nitrogen as compared to 310,000 during 1959-60. It is surprising that such a low price should have been accepted by the European producers who have a virtual monopoly in this market because the United States and Japanese are not in a position to offer for political reasons.

Prices in Spain, however, have been well maintained in spite of the continuance of the anti-dumping duty of pesetas 420 per ton and the 10% to 15% *ad valorem* duty. The issue of import licences in quantity commenced again in November 1960 and since then and up to mid-May 1961 amounted to 140,000 tons of pure nitrogen. The sulphate of ammonia bulk prices ranged from $30 to $31 per ton f.o.b. according to the port of shipment, calcium ammonium nitrate from $31.00 to $33.50 and calcium nitrate from $37.00 to $37.50.

In India ammonium sulphate was sold at £13 9s. 6d. per ton f.o.b. in bags, 9s. 6d. less than the previous purchasing price.

In Korea under the " Buy American " policy the United States sold 36,500 tons of urea at prices ranging to $124.90, c. and f. U.S. liner terms and $115.17 c. and f. non-U.S.A. flag, and 18,200 tons of ammonium sulphate at a price of $57.22, c. and f. non-U.S.A. liner terms.

Japan was the only other supplier for 70,500 tons of urea at a price ranging from $91.00 to $91.50 c. and f. U.S.A. liner terms.

In Pakistan ammonium sulphate in bags was sold from Europe at $41.90 c. and f. liner terms and 50% less for chartered vessel and urea at $95.80 c. and f. liner terms.

0 cents less for chartered vessel and urea at $95.80 c. and f. liner terms.

In the recent urea tender issued by the Sudan Gezira Board, urea was sold by Norway, 8,000 tons; Holland, 6,000 tons; Germany, 7,000 tons; Italy, 3,000 tons; and Japan, 8,000 tons.

In the United Kingdom, domestic prices of ammonium sulphate have been reduced by 12s. 6d. per long ton for the 1961-62 season and the Government subsidy from £9 9s. 0d. per long ton to £8 15s. 0d. Calcium ammonium nitrate 21% N (nitro-chalk) has been reduced by £1 1s. 6d. per long ton.

ESTIMATES OF PRODUCTION AND CONSUMPTION

(Statistical data compiled in conjunction with British Sulphur Corporation Limited)

The following are our revised estimates of production and consumption throughout the world including the U.S.S.R. in summary form for the fertilizer years 1956-57 to 1961-62.

SUMMARY OF WORLD NITROGEN PRODUCTION AND CONSUMPTION

	1956/57		1957/58		1958/59		1959/60		1960/61	
	Prod.	Con.	Prod.	Con.	Prod.	Con.	Prod.	Con.	Prod.	Con.
Western Europe	3,954	3,066	4,248	3,393	4,606	3,741	4,930	3,930	5,100	4,170
North America	3,288	3,035	3,675	3,480	3,712	3,612	3,970	3,750	4,350	4,050
Central and S. America	227	329	234	343	281	385	300	434	340	500
Africa	17	98	22	100	25	118	35	163	40	210
Australasia	25	43	25	42	26	43	22	35	20	37
Middle East	47	195	49	224	54	224	70	252	85	290
Asia	1,301	1,752	1,501	1,892	1,542	2,065	1,690	2,228	1,824	2,450
Eastern Europe	1,441	1,446	1,586	1,645	1,758	1,795	1,965	1,965	2,160	2,100
	10,300	9,964	11,340	11,119	12,004	11,983	12,982	12,757	13,919	13,807
Less for Industrial Purposes ...	1,446	1,446	1,550	1,550	1,755	1,755	1,895	1,895	2,000	2,000
Total	8,854	8,518	9,790	9,569	10,249	10,228	11,087	10,862	11,919	11,807

IMPORTS AND EXPORTS

As advised in our Annual Report for November 1960 we include in this report our estimates of exports and imports which are as follows:—

IMPORTS OF NITROGEN
('000 tonnes N content)

EUROPE	1956/57	1957/58	1958/59	1959/60
Austria	1	1	1	3
Belgium	8	8	15	14
Bulgaria	—	9	22	44
Czechoslovakia ...	17	13	16	34
Denmark	96	103	100	115
Finland	22	20	19	23
France	16	19	18	16
Germany (East)	—	—	—	11
Germany (West)	4	3	3	5
Greece	52	70	75	77
Ireland	16	18	21	21
Italy	8	14	8	6
Netherlands ...	16	19	17	24
Poland	6	—	—	5
Portugal	26	45	33	39
Spain	142	150	236	193
Sweden	62	55	57	62
United Kingdom	12	21	44	69
Jugoslavia ...	49	64	100	61
Switzerland ...	1	1	1	1
TOTAL ...	554	633	786	823

MIDDLE EAST	1956/57	1957/58	1958/59	1959/60
Cyprus	4	6	7	6
Israel	2	2	2	2
Lebanon	5	4	5	5
Turkey	10	13	21	9
United Arab Repub.				
Egypt	143	157	67	70
Syria	4	4	3	5
TOTAL	168	186	105	97

AFRICA	1956/57	1957/58	1958/59	1959/60
Algeria	—	7	9	13
Central Africa Feder.	—	31	25	35
Rep. of South Africa	—	13	14	19
Others	—	22	28	47
TOTAL ...	50	73	76	114

NORTH AMERICA	1956/57	1957/58	1958/59	1959/60
United States ...	267	277	267	270
Canada	13	13	13	13
TOTAL ...	280	290	280	283

CENTRAL AMERICA	1956/57	1957/58	1958/59	1959/60
Costa Rica	3	3	4	8
Cuba	10	12	12	25
Dominican Rep. ...	2	7	3	8
Martinique and Guadeloupe ...	3	3	4	6
Guatemala	5	—	5	7
Honduras	2	3	2	2
Mexico	65	70	84	91
Feder. West Indies				
Barbados ..	2	3	2	2
Jamaica ...	5	6	6	2
Trinidad & Tobago	3	3	4	2
Salvador	4	5	6	8
Panama	1	2	2	3
Others	5	6	6	5
TOTAL	110	123	140	164

SOUTH AMERICA	1956/57	1957/58	1958/59	1959/60
Argentina	5	7	9	10
Brazil	28	30	37	42
British Guiana ...	4	4	4	4
Chile	1	1	1	1
Colombia	6	9	6	10
Ecuador	4	3	6	3
Peru	12	16	18	23
Uruguay	2	2	2	2
Venezuela	2	2	4	9
TOTAL	64	74	87	104

ASIA	1956/57	1957/58	1958/59	1959/60
Thailand	3	5	8	9
Burma	1	1	1	1
Ceylon	26	20	30	28
China	225	315	326	305
Taiwan	66	70	74	73
Malaya	16	15	20	22
India	57	111	102	123
Indonesia	25	24	43	29
Japan	2	2	2	2
Korea (South) ...	159	144	151	185
Pakistan	39	3	6	18
Philippines ...	12	29	35	38
Ryuku Is.	3	3	3	5
Viet Nam	6	13	20	33
TOTAL	640	755	821	871

AUSTRALASIA	1956/57	1957/58	1958/59	1959/60
Australia	10	11	12	12
New Zealand ...	2	2	2	2
Fiji	1	2	2	2
TOTAL	13	15	16	16

EXPORTS OF NITROGEN

('000 tonnes N content)

EUROPE	1956/57	1957/58	1958/59	1959/60
Austria	115	108	117	116
Belgium	130	189	198	227
Bulgaria	3	4	4	—
France	34	62	46	70
Germany (East) ...	90	83	96	102
Germany (West) ...	368	469	430	493
Italy	118	127	199	267
Netherlands ...	159	200	201	217
Norway	164	168	170	195
Poland	—	—	40	17
Portugal	2	3	3	3
Sweden	—	—	—	5
U.K.	11	64	49	52
Switzerland ...	1	3	6	6
TOTAL ...	1,195	1,480	1,559	1770

NORTH AMERICA	1956/57	1957/58	1958/59	1959/60
U.S.	238	207	202	171
Canada	156	156	157	161
TOTAL ...	394	363	359	332

OTHERS	1956/57	1957/58	1958/59	1959/60
Chile	229	193	178	177
Japan	192	248	301	345
TOTAL ...	421	441	479	522

AIKMAN (LONDON) LTD., BROKERS

Nitrogenous Fertilizers In Australia

- **Duty on imported N fertilizers**
- **N fertilizer requirements**
- **I.C.I. A.N.Z.'s N fertilizer project**

FOLLOWING a Tariff Board enquiry into the need to protect the Australian nitrogen fertilizer industry in relation to imports of ammonium sulphate, urea and other products covered by Tariff Item 403 (E), that is, synthetic chemical compounds and mixtures containing nitrogen suitable for use separately or in conjunction with other products as fertilizers, the Australian Minister of Trade, Mr. J. McEwen announced that as from 24 May 1961, a temporary duty would operate on imported nitrogenous fertilizers. The duty is levied on the N-content of fertilizers at the rate of £A1.5s. per cwt. N. Specified quantities of urea — 10,000 tons — and other nitrogenous fertilizers — 13,000 tons — imported for domestic consumption on or before 31 May 1962, are exempt. Arrangements have been made to exempt from the temporary duty any products containing nitrogen imported for use other than as fertilizers.

A Temporary Measure

The new duty is in addition to the existing non-protective tariff, under which ammonium sulphate and urea were admitted free of duty under the British Preferential Tariff and at 7½% *ad valorem* in the case of the imports of most favoured nation origins; other nitrogenous fertilizers were imported free of duty irrespective of origin. The duty will only operate until the Australian Government has taken action on the final report of the Tariff Board and in any event not for more than three months after receipt of the report.

Production and Imports

The question of the Australian nitrogen fertilizer industry's normal protective needs was referred to in the Tariff Board on 26 September 1960, following a demand for protection by the industry, and public hearings were held on 26 April and 30 May this year. Producers of ammonium sulphate—Electrolytic Zinc Co. of Australasia, Broken Hill Proprietary Company Limited, Australian Iron and Steel Company of Australia Limited and the Australian Gas Light Company gave evidence as well as the Queensland Cane Growers' Council, the Council Agriculture (Queensland), the Orchadists and Fruit Cool Stores Association of Victoria, the Australian Apple and Pear Growers' Association, the Australian Canning Fruitgrowers' Association and the National Farmers' Union of Australia.

Domestic N Fertilizer

Ammonium sulphate is at present the only nitrogenous fertilizer manufactured in Australia. Urea is imported and next to ammonium sulphate has become the principal and a competitive form of fertilizer nitrogen. Imports include calcium ammonium nitrate, complex fertilizers and some Chilean nitrate.

The supply picture presented at the enquiry was as shown below.

Current demand for nitrogenous fertilizers is estimated by the Australian manufacturers as the equivalent of 130,000 tons of ammonium sulphate on the following basis. (See next page.)

Period	Local Production: Sulphate of Ammonia tons	Imports: Sulphate of Ammonia tons	Imports: Urea (a) tons	Imports: Other Fertilizers tons
Year ended June 1958	118,700	20,945	6,840	2,121
Year ended June 1959	117,500 (b)	19,979	9,115	10,885
Year ended June 1960	103,300 (b)	11	9,376	6,635
9 months ended March 1960 ...	77,600			
9 months ended March 1961 ...	73,400	110	15,600	14,300

(a) The equivalent of urea imports in terms of ammonium sulphate are:—
1957-58 .. .. 15,000 tons (all grades)
1958-59 .. .. 20,000 tons (all grades)
1959-60 .. .. 20,500 tons (all grades)
*9 months ended March 1961 .. 34,000 tons (fertilizer grades only)

(b) Coinciding with withdrawals of Government factories.

	Ammonium Sulphate (tons)
Ammonium sulphate	100,000
Urea (9,130 tons)	20,000
Other	10,000
Total	**130,000**

Capacity in Australia is about 115,000 tons ammonium sulphate; current production is deemed to be 100,000 tons of ammonium sulphate so that the equivalent of 30,000 tons ammonium sulphate in the form of urea or other nitrogenous fertilizers must be supplied by imports.

The Tariff Board recommendations, based on trade views, reflect this in exempting from protective duty 10,000 tons of urea and 13,000 tons mixed or "complete" fertilizers containing 10% to 26% N, including calcium ammonium nitrate, of which in recent years up to 4,000 tons a year has been imported.

Domestic Surplus

The demand for protection became vocal when, despite a heavy reduction of domestic ammonium sulphate prices in 1959 from £A36 to £A31 per ton, sales failed to improve and imports of urea and complex N fertilizers continued to rise, in the view of local manufacturers, beyond the volume required to bridge the difference between production of ammonium sulphate and total usage of fertilizer nitrogen. It was claimed that landed costs of the imported fertilizers up to May this year were at a level that threatened the cost and price structure of local industry which was operating at an apparent loss, virtually without tariff protection.

The excess of ammonium sulphate supplies over domestic demand forced Electrolytic Zinc to export, besides some ammonium sulphate under a Government quota to India, some 20,000 tons ammonium sulphate to China at world prices. The Government's decision to protect Australia's small nitrogen industry is conditioned by its reluctance to place reliance on the availability of N fertilizers from overseas, despite the present advantage of N fertilizer consumers from supplies landed in Australia at unit-N prices below those of Australian ammonium sulphate.

Low level of N-use

In relation to its agriculture and the use of P_2O_5, chemical nitrogen use is very low which is reflected by the plant nutrient ratio 1:23:1.1. In the main agriculture is extensive and the grassland needs of nitrogen are being met by clovers. It is significant that the intensively cultivated market gardens near cities and sugar plantations in Queensland are two major users of fertilizer-nitrogen. Pending greater intensity of cultivation of cereals and grasslands it is unlikely that Australia will become a major N-producer. In recent years several projects, notably for urea, have been mooted and long term prospects for new plants, as exemplified in the following report on W. Australia have been highlighted.

Opportunities

"Opportunities for Industrial Development in Western Australia," a comprehensive report published by nine U.K. Industrialists following a visit to Western Australia comments that apart from use of superphosphate, trace elements, clover, and recycled dung, very little nitrogenous fertilizer is used. Imports in 1959-60 for this area were only 826 tons N. It is pointed out that the rate at which legumes can fix nitrogen has a definite limit and Western Australia will be no exception to the rule that, as agriculture becomes more intensive, nitrogenous fertilizers are needed in increasing quantities. A project for making nitrogenous fertilizers in Western Australia is therefore foreseen not only in view of the certainty of future demand but by the existence in that part of the continent of a favourable raw materials situation. The Collie Coalfield which is located in the centre of the agricultural area and with good access to a seaport is most likely to be developed intensively.

Urea is suggested as the N-fertilizer of preference. Later products would be anhydrous ammonia as a fertilizer, for general industrial purposes and for export to rubber-producing areas, and nitric acid for fertilizers, explosives and general industrial purposes. Later still, the project could develop into the manufacture of ammonia liquor, ammonium sulphate, ammonium phosphate, methanol and formaldehyde. It is further suggested that, given con-

firmation of low coal price and technical suitability of the coal and site, it might be possible to envisage exports of these Nitrogenous materials without waiting for demand to arise within the State, as there is no reason in principle why Western Australia should not become one of the main suppliers to countries around the Indian Ocean.

New Ammonia and Urea Project

The recent decision of I.C.I. A.N.Z. to build an ammonia/methanol plant at Botany, N.S.W., is, however, the first step towards the establishment of a versatile N-industry. Site preparation is already well advanced and due to be completed by 1963 at a cost of £A6 million, the plant will consist of five units and will produce 63,000 tons of products. These include urea in quantities insufficient to satisfy Australia's immediate demands, nitric acid and ammonium nitrates. A major factor contributing to the decision to instal large-scale ammonium nitrate production capacity is the rapidly growing use of ammonium nitrate and fuel mixtures as industrial explosives, replacing conventional nitroglycerine types. The new project will result in the closure of existing small plants (5,000 tons a year NH_3 each) at Villa Wood, N.S.W., which I.C.I. bought from the Australian Government and Deer Park, Vic. The ammonia plant at Ballarat, Vic. (5,000 tons a year NH_3), also ex-Government, is to be expanded at a rate dependent on future demand for fertilizer nitrogen.

Coating and Packaging Fertilizer Urea

COATING materials for minimizing moisture absorption by urea during storage have been studied by M.B. Karmath *et. al.* of the Indian Agricultural Research Institute, New Delhi, India. Of a variety of materials tried, a 5% solution of wax in kerosene is reported to give the best results, moisture absorption by urea stored in jute bags for a month being reduced from 3.5 to 0.9%. The coating has been found to have no adverse effect on release to the soil of nitrogen present in the fertilizer.

Bags Under Test

Bags with different moisture proof linings have been under test at Sindri Fertilizers and Chemicals Limited for moisture impermeability and mechanical strength after storing urea for four months.

Describing the studies S. Varina reports that: (1) polyethylene liners of varying thickness, (2) crêpe paper pasted with bitumen to jute, (3) two piles of lagging paper laminated and pasted with bitumen to jute and (4) polyvinylidene chloride-coated jute bags were tried. For comparison unlined jute bags were provided.

Relative effectiveness of the bags was evaluated on the basis of (a) moisture content of urea before and after test; (b) caking of urea; (c) physical conditions of the lining and bag, and (d) mechanical strength of the liner. The tests were conducted during the monsoon season (July to October).

Storing Urea

Prilled urea was filled into the sacks which were then stitched and kept under pressure by putting five sand bags (total weight 350 kg.) above each bag. The bags were stored on a wooden platform above floor level. Mechanical strength of the bags was determined by dropping some of the bags from a height at various intervals. Moisture content of the urea in the bags was determined by sampling and drying the sample over concentrated sulphuric acid.

Results of the tests show that urea packed in polyethylene-lined bags absorbed least moisture and caked less, and the bags could withstand rough handling better than other bags. Polyethylene liners stitched to the jute bag proved better than the loosely inserted ones. Also found advantageous is the use of liners of slightly larger dimension than the jute bag.

Colombia's Nitrogen Fertilizer Production

Barrancabermeja plant now near to completion

DESPITE impressive steps towards greater industrialisation, agriculture remains Colombia's chief industry, with some 60% of the country's population engaged in the work. Besides being the main source of national income, agriculture also supplies most of Colombia's food requirements and about 85% of its earnings of foreign exchange. At the same time, as a result of deliberate Government policy, in the immediate post-war years, the relative importance of the agricultural sector has declined and the manufacturing industries, backed largely by United States investment, have increased their share of the national product.

Coffee is the mainstay of Colombia's economy, representing over 75% of its earning of foreign exchange. As a result, the Colombian economy is particularly susceptible to fluctuations in world commodity prices. World overproduction of coffee in recent years has resulted in the accumulation of large stocks and the price of Colombian coffee has fallen from 63 cents/lb. in 1957 to 45 cents lb. in 1960. Consequently, Colombia's ability to finance internal development has been severely impaired.

Agricultural Investment

Since 1957, the Government has endeavoured to increase agricultural investment and promote a more efficient land utilisation. Agricultural research stations have been established and liberal credits and tax advantages are available to agriculture, in contrast to other sectors of the economy where credit is strictly controlled.

As a result, production of export crops has increased. On the other hand output of foodgrains has not increased to any significant extent, and substantial quantities of wheat and wheaten products are imported every year.

The importance of fertilizers in raising agricultural output has long been recognized by the Government and in 1953 at the height of the coffee boom, construction of a Government sponsored nitrogenous fertilizer plant was begun by Montecatini at Barrancabermeja. Progress from that year has been held up periodically through lack of funds, but adequate funds now seem to be available for completion.

To finance machinery purchases for the new fertilizer plant, an Italian bank has granted a five-year's loan of 16 million pesos to Industrias Colombiana de Fertilizantes S.A. of Bogota, the company which will operate the plant. Estimated cost of the project is $8 million, much of which Colombia hopes will be provided by a U.S. Export-Import Bank loan.

Nitrogen Fertilizer Production

The plant is due to be in production by 1962, but plans are already being made to increase capacity of the anhydrous ammonia plants to 150 tons a day, and that of all other nitrogen products accordingly. These plans are based mainly on domestic consumption. No export of nitrogenous fertilizer is foreseen. At present the rated daily capacities of the plant are 50 tons a day anhydrous ammonia, 50 tons 100% NHO_3), nitric acid as 53% acid, 100 tons a day ammonium nitrate (33% N) and 200 tons of complex fertilizers of various N, P and K formulations. Feedstocks for the plant will be natural gas from the Shell Casabe oilfields. Seventy per cent of civil engineering work is completed and 90% of the equipment is in the site and in process of erection.

International Petroleum (Colombia) Ltd. (Intercol) is projecting a synthetic nitrogen plant. Its subsidiary, Amoniaco del Caribe (Amocar), is to operate a plant at Cartagena which is to have a daily capacity of 325 s. tons ammonia and 167 s. tons 100% HNO_3. Some 125 s. tons ammonia will be exported, and about 50 s. tons used for nitric acid manufacture which together with 150 s. tons ammonia, will be available for domestic consumption.

Intercol will own and operate the ammonia and nitric acid plants and fertilizers will be produced by Sociedad Organizadora de la Industria de Abonos y Productos Quimicos — in which U.S., German and Colombian firms are the shareholders—using the ammonia and nitric acid from the Cartegena plant. Manufacture of urea, ammonium nitrate and a range

*NITROGEN No. 10, page

of complex fertilizers is planned.

Intercol is reported to have announced that it will use refinery gases from Mamonal, near Cartagena, for the 115,000 s. tons a year ammonia plant.

By 1963/4 therefore, installed capacity in Colombia is likely to amount to about 100,000 s. tons of fixed nitrogen.

Consumption of straight nitrogenous fertilizers in Colombia has declined from a level of some 7,000 tons N in 1956 to some 4,000 tons N in 1959 but has largely been counterbalanced by an increase in complex fertilizer consumption of some 20,000 tons. In the immediate future, it is anticipated that supplies from the Government plant will be adequate to meet domestic demand and that the output of the Cartagena plant will be mainly exported. Longer term, however, it is likely that fertilizer consumption will significantly increase but is unlikely to reach the level of production before 1967.

. . . . The Fertilizer Plant at Barrancabermeja

CONSTRUCTION started in 1956 at Barrancabermeja on Colombia's first nitrogen fertilizer works, but has been held up because of lack of funds. It had been hoped to complete the plant by 1960, but it is now expected that it will be brought into operation during the first half of 1962. The U.S. $8 million fertilizer complex has been designed by Soc. Montecatini and will use that company's manufacturing processes. Seventy per cent of civil construction is completed and 90% of the equipment is on the site and in process of erection.

The project is being handled by Instituto de Fomento Industrial and when completed will be operated by Industria Colombiana de Fertilizantes S.A.

Hydrogen for ammonia synthesis is to be derived from natural gas from Shell Company's oil fields at Casabe. Anhydrous ammonia capacity is projected at 50 tons NH_3 a day, and plans based mainly on estimated domestic consumption are already in hand to increase capacity to 150 tons a day.

Process and Plants

Natural gas purified to contain only traces of sulphur compounds will be piped to the reducing station at the plant where the main gas line will divide into three to supply the cracking plant, gas turbines, the power plant and minor fuel requirements.

Natural gas at low pressure will pass to the cracking plant, together with superheated steam and oxygen-enriched air. In the reactor, equipped with a nickel catalyst fixed bed, hydrogen, carbon dioxide, carbon monoxide, unreacted natural gas (CH_4) and nitrogen will be obtained. The incoming stream will be heated by the outgoing gases, which will be compressed to 13kg./cm^2. The gases will pass thence to a shift converter, where a pelletted iron catalyst will accelerate the reaction

$$CO + H_2O \rightleftharpoons H_2 + CO_2$$

forming addition H_2. The converted gas will then be treated in water and caustic soda scrubbing towers to remove most of the CO_2, which is purified for subsequent use as raw material in the manufacture of urea. The remaining gas—hydrogen with some impurities and N_2—hydrocarbon and CO will pass to the gas fractionation section to remove nitrogen and the remaining impurities, composed of hydrocarbon and CO.

Nitrogen Production and NH_3 Synthesis

A liquid air distillation plant will produce nitrogen gas of very high purity. Both gas and cracking air distillation plants are being produced by Linde AG. of West Germany.

Ammonia synthesis by the Fauser-Montecatini process is effected at high pressure (250 to 350kg./cm^2) and temperature in a multiple-bed reaction tower, using an iron oxide type catalyst. The catalyst beds will be cooled and the temperature controlled by means of the Fauser-Montecatini system of internal circulating water coils. This system allows constant and accurate control of the main process variables—pressure, temperature and concentrations. Hot gases leaving the synthesis tower are further cooled at high pressure so as to condense most of the ammonia formed by the

reaction. The unreacted gases are recycled to the reactor.

Some of the anhydrous liquid ammonia is vapourized to serve as raw material for the nitric acid plant and the ammonium nitrate plant. The liquid ammonia is also used as raw material for urea manufacture and for cooling; liquid ammonia storage facilities will be provided. The Fauser-Montecatini process affords substantial heat recovery in the form of process steam.

Nitric Acid

Nitric acid (53%) for ammonium nitrate manufacture will be obtained in an 80-tonne-a-day (100% HNO_3) plant of Montecatini's design. The process for this plant is as follows: The raw materials, ammonia gas and air, are thoroughly mixed and then reacted using a platinum-rhodium catalyst in a special burner. The combustion gases, mostly nitrogen monoxide, are cooled and then oxidized to nitrogen dioxide in special vertical water-cooled towers. The nitrogen oxide is absorbed in water to nitric acid 53% concentration. This step is effected in a horizontally-laid tubular system in which the water travels downward and the gases upwards, so that the nitric acid formed is progressively concentrated. Air is blown through the nitric acid product of the lowest section to remove any gaseous nitrogen oxides remaining and the acid is passed to storage. Process air is supplied from a turbo compressor which utilizes hot tail gases. The desired ratio of O_2/NH_3 in the burner is automatically controlled and it is equipped with safety devices.

Ammonium Nitrate Plant

The raw materials for the 100-tonnes-a-day (33% N) ammonium nitrate plant—gaseous ammonia and 53% nitric acid—are reacted in a Fauser chamber where the reaction takes place in the liquid phase. By means of an automatic pH controller, the pH is kept constant. Ammonium nitrate solution formed flows to a concentration chamber where the solution is concentrated to 94% by means of steam coils.

The concentrated solution passes over an endless screw-type mixer where it combines with recycled ammonium nitrate fines to form a paste-like material that is passed to a hot air rotating cylinder drier which both dries and granulates the ammonium nitrate. The granulated fertilizer will be taken by a system of elevators and conveyors to vibrating screens where the desired granular fraction is separated from the coarse and fine fractions. The coarse fraction is recycled to the dryer outlet after being reduced in a roller mill. The fines are returned to the screw-mixer.

The ammonium nitrate granules are fed to a rotating drum where they are coated with a specially powered clay to prevent agglomeration and then passed to the packaging section. Some modifications have been made in the design of this plant, to permit potassium chloride and superphosphate to be incorporated into the final product. Compound fertilizer output is planned at a daily rate of 200 tonnes.

Urea Plant

The 30 tonnes-a-day urea plant will receive liquid ammonia from storage and the CO_2 from the converter gases.

CO_2 and liquid ammonia will pass to a synthesis tower at about 200kg./cm^2. Ammonium carbamate forms first and then some of it decomposes to give urea and water. A system of expansion and evaporation causes urea to separate from carbamate, ammonia, CO_2 and water. Finally a molten product comprising 98% urea is obtained which is sprayed from the top of a prilling tower. The prilled urea is screened and then packed. Any unused ammonia and CO_2 are recycled to the synthesis tower.

Auxiliary Plants

Electric power and water treatment facilities have been provided for the project. Plants for production of the required electric power, demineralized water, cooling water and drinking water, are now in the course of erection. Other plants being provided include the causti-fication plant, where carbonated caustic soda, after purification, is regenerated in a Dorr plant; the desulphurization of the CO_2 gas stream for urea synthesis using iron oxide purification boxes; and the clay preparation plant for coating ammonium nitrate granules.

All the other necessary facilities, such as machine and equipment shops, general warehouse, storehouses, sanitary and personnel welfare facilities, administration buildings, etc., are also to be provided.

Hungary's Expanding Nitrogenous Fertilizer Industry

Output expected to rise to 720,000 tonnes products by 1965

PARALLELLING the trend in other Eastern European countries, the fertilizer industry in Hungary is being significantly expanded and developed. In recent years nearly a quarter of all chemical industry investment has been aimed at increasing nitrogenous fertilizer output and this will be maintained, at least for the next five years. As a result, a fivefold increase in production was achieved in the 10-year period 1949-1959 and planned extensions and new capacity will raise eventual ammonia capacity to a level of 168,600 tonnes N.

Low Fertilizer Usage

As a result of Government policy, the production target is almost certain to be achieved, but it is doubtful whether nitrogenous fertilizer consumption will keep pace with production. The Hungarian economy, despite impressive steps towards greater industrialisation, is primarily agricultural; nitrogenous fertilizer use, however, is low, and only amounted to some 4.4 kilos N per hectare of agricultural land in 1958. Although the new facilities planned will result in greatly reduced fertilizer prices, it is expected that a considerable amount of market development work will be necessary to increase consumption, and, over the short term, Hungary may have sizeable surpluses of nitrogenous fertilizers available for export.

Nitrogen Production in Hungary
1932-1945
(excluding by-product ammonia)
Tonnes N

1932	679	1939		5,402
1933	296	1940		7,330
1934	4,509	1941		7,393
1935	5,044	1942		7,738
1936	5,889	1943		8,092
1937	6,342	1944		3,847
1938	5,176	1945		—

1946-1959
(excluding by-product ammonia)
Tonnes N

1946	149	1953		11,680
1947	868	1954		12,807
1948	8,358	1955		12,370
1949	10,653	1956		19,352
1950	12,498	1957		16,372
1951	13,013	1958		31,365
1952	12,182	1959		48,652

Plants

The first nitrogenous fertilizer plant in Hungary, the Pet Nitrogen Works, was installed in 1932 at Petfurdo and used coke oven gas as a raw material for synthesis gas manufacture. The entire output of the plant was in the form of calcium ammonium nitrate, 20.5% N, and production fluctuated from 5,000 to 8,000 tonnes N annually until 1945 when the plant was damaged.

After the war the fertilizer industry received intensive attention. The Pet Nitrogen Works was reconstructed and enlarged, and erection of a 36,000 tonnes-a-year ammonia plant commenced at the Borsod Chemical Combine at Kazinbarcika, financed by Russian aid. Production at Petfurdo recommenced in 1946, and the plant was expanded by 50% in 1956. In 1958, the Borsod ammonia plant came into partial operation, and in 1959 the combined output of the two plants amounted to 48,652 tonnes N, over seven times the level of production achieved in prewar years. A number of modifications developed at the Pet Nitrogen Works were incorporated at the Borsod factory, and power and synthesis gas requirements per ton of ammonia are significantly lower at the latter facility.

Apart from a small quantity of by-product ammonium sulphate, 6,500 tonnes in 1959, the entire Hungarian fertilizer production is in the form of calcium ammonium nitrate. Industrial usage of nitrogen in Hungary amounts to some 4,500 tonnes only.

Calcium Ammonium Nitrate Production
Tonnes

1957	79,863	1959	237,328
1958	152,999	1960*	254,488

* 11 months

Natural Gas as Feedstock

Between 1950 and 1955, investment in the fertilizer industry accounted for 23% of total chemical investment and in the second Five-Year Plan, commencing in 1961, it is envisaged that the same percentage of a substantially higher investment in the chemical industry will

Hungarian Ammonia Capacity		
		Total Capacity Tonnes NH_3
1956	Pet expansion completed	33,000
1959	Borsod plant completed	69,000
1963	Borsod expansion completed ...	105,000
1965	Tiszapalkonya plant completed ...	205,000

be devoted to the fertilizer industry. For a number of technical reasons, such as limitations of raw materials and water, lack of adequate space, etc., the Pet Nitrogen Works will not be expanded further, but a doubling of capacity is projected at Borsod and a very large—100,000 tonnes per annum—ammonia plant will be erected at Tiszapalkonya in north - east Hungary. At present, all ammonia manufacture is based on coke-oven gases, but in the future, Tiszapalkonya will use as raw material natural gas, almost pure methane, piped from Buciumen in Rumania, 227 miles away, and the expanded facilities at Borsod will also use Rumanian natural gas. It is expected that by 1965, when all the projects have been finalised, 80% of Hungarian nitrogenous fertilizer production will be based on natural gas and only 20% on coke-oven gases. As a result, manufacturing costs are expected to decline sharply. The U.S.S.R. will supply the plant and equipment for both Borsod and Tiszapalkonya, and both are scheduled for completion by 1965.

Until the beginning of 1959, Hungarian nitrogenous fertilizer output was wholly in the form of lime ammonium nitrate, 20.5% N. In that year, the nitrogen content of the material produced at both Pet and Borsod was increased to 25% N and it is expected that substantial economies in storage, transport, handling and application charges will result. Granular lime ammonium nitrate 25% N will also be produced at Tiszapalkonya where facilities for urea manufacture will also be included. It is envisaged that the bulk of the urea produced will be for industrial use, and only insignificant quantities are expected to find a use as a fertilizer.

N Production in 1965

By 1965, total production of nitrogenous fertilizers will amount to 720,000 tonnes of products, over three times the present output. As a result, Hungary hopes to increase fertilizer usage per hectare of agricultural land from its presnt level of some 7 kilogramme N to a level of 20.6 kilos N over a cultivated area of 7.1 million hectares, by 1965. Such an application rate will, however, be low by other European standards and fall far short of Hungarian optimum nitrogen application rates which have been estimated at 80 to 85 kilogramme N per hectare of agricultural land.

The Hungarian nitrogen industry is expected to accomplish a three-fold increase in capacity over the next five years. While the bulk of this new capacity will be used for nitrogenous fertilizer production, increasing quantities of synthetic ammonia will be utilised by other industries. Lime ammonium nitrate will be, apart from some 10,000 tonnes of by-product ammonium sulphate and a small quantity of urea, the only fertilizer produced, but the manufacture of complex fertilizers based on nitrophosphate has been under study and may be undertaken later.

PHILIPPINES

Artist's impression of the $13 million integrated fertilizer copper zinc plant of Marinduque Iron Mines Inc. It will produce 98,000 tons ammonium sulphate and 15,000 tons urea as well as 14,000 tons of copper and 5,000 tons zinc (see Nitrogen 10, P.19)

Alkali Inspectors' Report

Decline in Production of Concentrated Ammonia Liquor

CONCENTRATED ammonia liquor output has declined by 4,400 tons (25% NH_3) for England and Wales, and in Scotland by 810 tons. By-product sulphate of ammonia has increased by 1,700 tons in England and Wales, and in Scotland it declined by 1,010 tons. Output of synthetic sulphate of ammonia, which is confined to England and Wales, rose by 41,700 tons. These are the findings reported in *the 97th Annual Report on Alkali & C. Works by the Chief Inspectors 1960.*

The drop in concentrated ammonia liquor in England and Wales and Scotland can be associated with the continuous concentration of the gas and coke industries in England and Wales. Registrations were 430 compared with 454 in 1959 and 477 in 1958, and similarly in Scotland they declined from 115 to 104. Towards the end of 1960 the large total gasification Lurgi plant in Fife began commissioning trials and when fully commissioned a further and probably more substantial drop in the number of gas works is expected.

Ammonium Sulphate Production

The England and Wales operations in the manufacture of ammonium sulphate have been such as to call for no more than the usual oral criticisms concerning supervision and maintenance. In Scotland, although ammonium sulphate continues to be manufactured at five shale works and coke-ovens production has continued to fall in recent years, plant design is such, the Alkali Inspector for Scotland reports, that there should be little cause for complaint about the foul gases which arise in the process.

Nitric Acid Manufacture

Manufacture of nitric acid by oxidation of ammonia is carried out at seven of the registered existing 78 plants. These include the plants of Imperial Chemical Iudustries Limited, at Billingham, Heysham and Huddersfield, of Fisons Limited at Stanford-le-Hope, of Shell Chemicals Limited at Shellhaven, and Lawes Chemical Company at Barking Creek. Recovery of nitric acid from various nitration, etc., operations is effected at 10 works.

At smaller nitration units the acid from the scrubbers is normally run to waste, usually after neutralising with lime. The Alkali Inspector for England and Wales records that plants for the manufacture of nitric acid and the larger nitration units are considered among the

AMMONIA PRODUCTS

England and Wales

(tons)

	1960	1959	1958
Conc. ammonia liquor from by-product liquor calculated at 25% strength	109,800	114,200	116,900
By-product sulphate of ammonia	284,200	282,500	310,200
Synthetic sulphate of ammonia	948,400	906,700	879,700

Scotland

	1960	1959	1958
Conc. ammonia liquor from by-product liquor calculated as 25% strength			
From gas works	2,930	3,740	3,320
From coke ovens	—	58,000	300
By-product of sulphate of ammonia			
From gas works	—	—	3,660
From shale ovens	98,001	7,320	7,740
From coke ovens	6,734	10,280	14,610
Synthetic sulphate of ammonia	—	—	—

major responsibilities of the Inspectorate. Acidities of the final escapes are being steadily reduced, it is reported, especially as older units are replaced. There still remains the difficulty of the colour of the emission to air, the brown plume being visible over a wide area. This colour problem has been satisfactorily overcome at the new units built in the Thames Estuary—the Shellhaven and Stanford-le-Hope works—by the catalytic combustion technique. Acidity of the waste gases, however, has not so far been reduced as far as had been hoped, in that complete reduction to nitrogen has not yet been effected. Emissions from the large units will continue to receive most serious attention.

The hope that there would be a good outlet for concentrated ammonia produced from by-product ammoniacal liquor of coal carbonization has not yet materialised. There is, however, some production of concentrated ammonia and a new plant was registered for the first time during the year, making seven registrations in all.

In Scotland bulk production of nitric acid is based entirely on the catalytic oxidation of ammonia gas and is carried out at Imperial Chemical Industries' Ardeer Plant. Last year I.C.I.'s old plant based on the oxidation of ammonia at atmospheric pressure, ceased production. The new plant uses pressure in absorption, unlike the old type, where oxides of nitrogen required absorption in an alkaline solution. The average acidity of gases discharged from plants manufacturing nitric acid was equivalent of 2.2 grains SO_3 per cu. ft., and the acidity of gases discharged from plants recovering nitric acid was 10.2 grains per cu. ft.

New Ammonium Phosphate Processes

A ROTATING BED of diammonium phosphate serves as a medium for neutralizing by anhydrous ammonia wet process phosphoric acid, according to a patent recently issued to U.S. Phosphoric Products, a division of Tennessee Corporation, Atlanta, Ga. (U.S. patent 2,963,359). The phosphoric acid is sprayed on to the top of the bed while the ammonia moves up from beneath. The bed is contained in a drum which is described as unique since it serves as a neutralization vessel, mixer, granulator and partial dryer. The final product is screened off the drum and passes forward for final drying.

Disadvantages inherent in some diammonium phosphate processes are reported to have been overcome by Woodhall-Duckham Construction Company Limited, London. In Australian Patent No. 59,982/60, the company reports a method of operating a coke-oven by-product plant using indirect ammonia recovery. The method requires the still temperature to be kept low enough to prevent diammonium phosphate decomposition.

Associated with Woodhall-Duckham is Koppers Company of Pittsburgh, U.S.A. The latter has built several coke-oven by-product installations incorporating saturators using phosphoric acid instead of sulphuric acid for production of diammonium phosphate. This process is only economically attractive in places where phosphoric acid is available cheaply. Only a small number of coke-oven plants in the U.S. are at present using it.

A Cause of Insoluble Phosphates

Losses can occur in ammonium phosphate manufacture through formation of citrate-insoluble phosphates in ammoniating wet process phosphoric acid. According to a recent report, the formation of the insoluble phosphates may be due to the presence of iron.

Investigations at two Canadian plants have shown that formation of citrate-insoluble phosphate formation may be minimized by ensuring a high pH value during ammoniation.

Aliphatic Nitrogen Compound as Acid Inhibitor

AN acid inhibitor, Armohib 31 which is an aliphatic nitrogen compound, for sulphuric, sulphamic, phosphoric or nitric acids in metal cleaning and pickling has been introduced by Armour Industrial Chemical, Chicago Ill. The nitrogen compound it is claimed, will not precipitate or cloud on use or standing; it is also non-staining and free from odour.

Urea As Inhibitor of Auto-oxidation in Fertilizers

Ensures satisfactory storage properties in bulk and in paper sacks

IN ORDER to increase the nitrogen content in mixed fertilizers, ammonium sulphate is being replaced by ammonium nitrate. Mixtures composed of ammonium nitrate and superphosphate have been found to undergo spontaneous heating when stored in large heaps, with temperature rises of 20 to 30°C being recorded over periods of weeks.

Recently the Department of Chemistry, Levington Research Station of Fisons Limited (K. S. Barclay and K. F. J. Thatcher) has investigated this spontaneous heating and methods for inhibiting it. As a result of their studies these investigators have found that urea added as an inhibitor of auto-oxidation to mixed fertilizers produces satisfactory storage properties, both in large heaps of fertilizers and in fertilizers stored in paper-sacks.

Spontaneous-Heating Studies

Spontaneous heating is accompanied by the evolution of gas, mainly carbon dioxide and nitrogen (ratio approximately 1:5) together with small amounts of nitrogen dioxide. The rate of the reaction increases with the acidity and decreases with increasing moisture content of the fertilizer. Decreasing the acidity of the mixture, sufficient to prevent self-heating, leads to a large and undesirable loss in water-solubility of the phosphate component owing to the formation of dicalcium phosphate. Increasing moisture content is not practical as it increases the tendency of the mixture to cake.

Superphosphate obtained from Morocco, Nauru, Florida or Gafsa phosphate rock contains organic matter (respectively 0.10%, 0.40%, 0.16% and 0.05%) which in a mixed fertilizer containing one of these superphosphates and ammonium nitrate, was oxidized by the nitrate under acidic conditions.

Following up work on the prevention of auto-oxidation of some organic nitro-compounds by substituted ureas or secondary amines* the Levington researchers found that addition of small amounts (0.25%) of urea effectively reduced oxidation of the organic matter and hence the self-heating of the fertilizers.

Effect of Urea on Reactivity of a Mixed Fertilizer

Source of Phosphate Rock	% Reduction in reactivity
Morocco	70.5
Florida	88.5
Nauru	92.0

Reduction of NO_2

It was also observed that urea reduced the amount of nitrogen dioxide involved.

Effect of Urea on Evolution of NO_2 in Mixed Fertilizer†

Phosphate Rock	Urea Content %	NO_2 envolved (ml./kg Fertilizer in 14 days)
Nauru	0.0	120.7
,, ...	0.10	28.7
,, ...	0.50	19.7
Morocco	0.0	49.3
,, ...	0.25	9.3
,, ...	0.50	4.0

† N 10%, P_2O_5 10%, K_2O 18%

It is suggested that nitrous acid is formed auto-catalytically, and hence suppression of oxidation by removal of the acid with urea, for example, should be possible.

To date 1¼ million tons of mixed fertilizers containing urea as inhibitor have shown satisfactory storage properties, both in large heaps and in paper sacks. In the case of the former, inhibition of the temperature rise overcame the caking tendency and subsequent difficulty in reclaiming from the heap, while the prevention of nitrogen dioxide formation overcomes chemical attacks on the paper sacks.

Now under investigation by Levington Research Station is the problem of self-heating of fertilizer storage-heaps due to inter-ionic reactions, such as can occur between ammonium nitrate and potassium chloride.

* British Patent No. 12745 (1912)

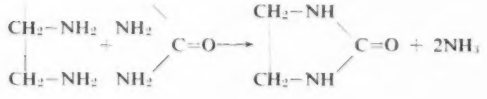
Dimethyol Ethylene Urea Plant for Russia

Manufacturing process and commercial applications

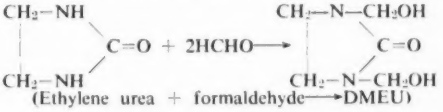
RECENTLY Wycon Services Ltd., a company formed jointly on a 50-50 basis between Fisons Ltd. and Constructors John Brown, for the design, supply and commissioning of chemical plants and chemical process technical know - how, obtained a contract worth more than £750,000 from Techmashimport of Moscow to build a 12,000 ton-a-year dimethylol in ethylene urea (DMEU) plant at Ufa, near Bashkiri, some 1,000 miles from Moscow. Design of the plant is based on know-how of Whiffen and Sons Limited, and DMEU resin will be produced in the form of a 50% aqueous solution. The plant, which will include an ammonia recovery plant and a urea unit will employ a fully automatic batch process, and is expected to be on stream in 1963. Output from the plant is expected to be adequate to supply all the drip-dry fabric treatment requirements in the U.S.S.R. over the next few years.

Manufacturing Process

Raw materials for the production of DMEU are ethylene diamine and urea. These are reacted and the mixture is heated to 250°C in a Pfaudler vessel with ethylene diamine in excess which is distilled off and recycled. Ammonia is evolved and is passed to a scrubber tower where it is absorbed. Molten ethylene urea is formed in high yield and is passed to stage 2.



The second stage of the process is a condensation reaction. Ethylene urea is reacted with aqueous formaldehyde in a stainless steel vessel at about 60°C and 50% aqueous DMEU is formed. This is filtered with charcoal and recycled until it is pure.



(Ethylene urea + formaldehyde → DMEU)

In the laboratory ethylene urea is heated with 0.5 mol of 36% aqueous formaldehyde at 72°C until dissolved, and is followed by the addition of aqueous HCOOH to pH 5 and one hour's reflux, when DMEU is formed.

Commercial Applications

Dimethylol ethylene urea is produced as a 50% aqueous solution which is diluted appropriately before applying to textile materials. The strength of the padding solution depends primarily on the percentage pick-up in the padder, but can also vary with the type of fabric being treated. For a 70% pick-up on the padder, a typical formulation would be:

50% DMEU solution ...	12% by weight
Catalyst	2-2.5% by weight
Water	to 100%

Metal salts such as magnesium chloride or zinc nitrate are the preferred catalysts since ammonium salts and amine chlorides tend to develop amine odours in the fabrics on storage.

Temperature of the padding solution is about 35°C during immersion of the fabric, but for heavy fabrics can be increased to 60°C to improve penetration. The padded fabric is dried at about 120°C, stretched out on a tenter frame to prevent wrinkles. The fabric is then cured for one to three hours at 150 to 175°C immediately following drying, and the cured fabric is then washed to neutralize acid from the catalyst and to remove traces of formaldehyde. Final pH of the fabric is 7 to 8.

current events

UNITED KINGDOM

Caprolactam and Nylon-6 Projects

Recent announcements have clarified the production plans for caprolactam and nylon-6 of the three companies which over the past year were known to have been considering these.

I.C.I. is to build a 15,000 ton-a-year caprolactam plant at the new Severnside site. The process to be employed will be one developed by Emser Werke AG./Inventa AG. of Switzerland, using toluene as raw material and yielding ammonium sulphate as by-product.

A 10,000 ton-a-year caprolactam plant will be set up by Courtaulds Ltd., most probably at the Spondon petrochemical complex of its subsidiary, British Celanese Limited. Courtaulds will use the Snia Viscosa toluene-based process, which also yields ammonium sulphate as by-product.

The third company interested in nylon-6 is British Enka Ltd., the U.K. subsidiary of A.K.U. of the Netherlands. The parent company is already a producer of caprolactam and nylon-6. British Enka, however, will not produce caprolactam in the U.K. at the site chosen at Irvine in Northern Ireland, but will most probably obtain supplies from its parent company.

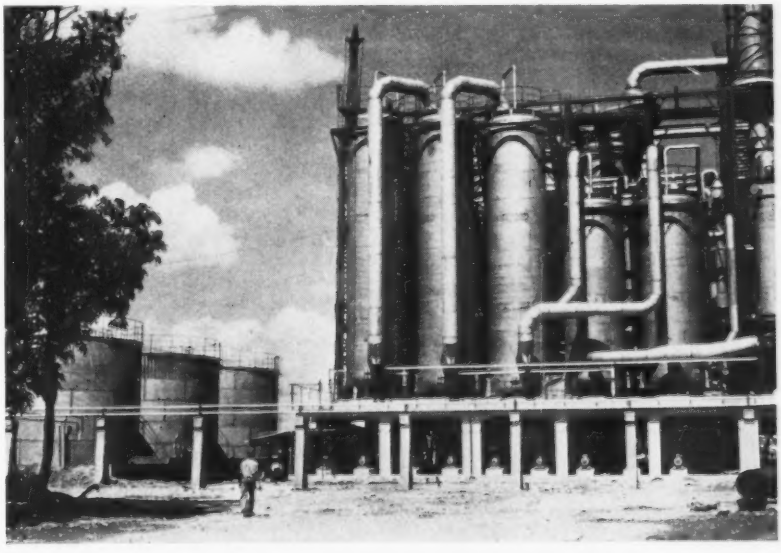
Both the I.C.I. and Courtaulds plants are due on stream in 1963 and the amount of ammonium sulphate that can be expected to be available from caprolactam manufacture will be about 120,000 tons a year related to plant capacity. Disposal of by-product ammonium sulphate should not prove a difficult task for I.C.I. in view of its established outlets to U.K. mixed fertilizer producers. Courtaulds, however, has to face the problem of finding a market for its by-product ammonium sulphate.

By-product ammonium sulphate from established operations in the U.S.A., the Netherlands, Western Germany and Italy has a high N-content of 20.6 to 21% N but adverse colour and physical properties, being pinky-grey and very fine. If used by mixers the by-product material should not, however, present too great a disadvantage.

INDIA

Naya Nangal Fertilizer Works

At the £26.3 million Nangal fertilizer works of Hindustan Chemicals and Fertilizers Limited which was brought on stream seven



The nitric acid plant at Nangal built by Pintsch Bamag AG.

months ago nitric acid production is reported to be exceeding 500 tonnes a day (100% HNO_3). The nitric acid plant — the largest of its kind in India — comprises two units each having a capacity of 280 tonnes (100% NHO_3) a day. Absorption is accomplished at 2.5 atmospheres. Other units in operation are reported to be working at rates greater than their designed capacities.

The main contractor appointed to the project by Hindustan Chemicals and Fertilizers was Saint Gobain S.A.* of Neuilly, which constructed in particular the lime ammonium nitrate plant and a number of ancillary installations within the plant project, and was also responsible for the procurements and overall construction. Saint-Gobain's associates, Societe Chimique de la Grande Paroisse, engineered the ammonia plant, while the nitric acid plant was built by Pintsch Bamag AG.* of West Berlin as sub-contractors.

AUSTRALIA

Nitrogen for Steelworks at Port Kembla

Commonwealth Industrial Gases Ltd., of Sydney, Australia, a member of the British Oxygen Group, has installed at Port Kembla, New South Wales, a 100 ton-a-day oxygen with nitrogen column attachment which produces nitrogen with a minimum purity of 99.5 at rates up to 30,000 cu. ft. per hour. The pure dry gas (dew point 40°C at one atmosphere absolute) is delivered to a neighbouring sheet steel works at 4 p.s.i.g. through an 8-inch diameter steel pipeline 2,500 in length, where the nitrogen is mixed with cracked ammonia and passed through a Deoxo system. The inert amosphere resulting from the use of nitrogen is required for a continous annealing and galvanizing line. This is the first plant of its type to be installed in Australia whereby both the oxygen and nitrogen are used.

UNITED STATES

Southern Nitrogen To Increase Ammonia Production By 50%

To meet the growing demand for its nitrogen products in the U.S. south-east and to permit marketing in border areas Southern Nitrogen Company, Inc. has announced a $5 million expansion programme. The principal additional facilities to be constructed at the company's Savannah, Georgia, works, will increase ammonia production capacity by 50% from 100,000 to 150,000 short tons a year; they are due to be in operation by July 1962.

Although Southern Nitrogen will receive 30,000 short tons of ammonia a year at Tampa, Florida, under a long-term purchase contract with Tennessee Corporation, its requirements in view of the rapidly mounting fertilizer demand will be considerably higher, necessitating the construction of the new production facility.

During the last ten years nitrogen consumption, according to Mr. John R. Riley, the company's president, has trebled in Florida and almost doubled in Georgia. Together with North and South Carolinas, these two states comprise one of the largest nitrogen fertilizer markets in the U.S.A. and about 90% of Southern Nitrogen's present sales are in these four states. The increased use of nitrogen fertilizers in this market area is attributable to the greater awareness on the part of farmers that they can thereby increase yields per acre and profitability.

Southern Nitrogen, which began operations in 1957, produces nitrogen solutions, prilled ammonium nitrate, ammonium nitrate limestone, *aqua* ammonia and urea. The company is now expanding its nitric acid and ammonium nitrate production at Savannah at a cost of $1.3 million. When the new nitric acid expansion is completed, Southern Nitrogen will have enough capacity to process the additional ammonia into end products. Potential ammonia supplies will be 150,000 short tons NH_3 a year at Savannah and Tampa, making Southern Nitrogen the third largest processor of ammonia, east of the Mississippi.

Armour's Nitrogen Fertiliser Complex

Construction has begun of the new nitrogen fertilizer manufacturing complex of Armour Agricultural Chemical Company at Chrokee, Ala. The new plant is being built under the company's $60 million expansion programme which in addition to the new nitrogen facility, includes construction of a plant

*In Nitrogen No. 11 it was reported that Vitro Engineering company of the U.S. had constructed the nitric acid unit and Sindri Fertilizers and Chemicals was responsible for the calcium ammonium nitrate facility. Vitro Engineering was the consultant engineering company for the Nangal project, and has not been engaged in engineering and constructing the plant.

to extract and process 700,000 - 800,000 tons a year of phosphate rocks producing phosphoric acid and triple superphosphate. Construction of the Cherokee plant is being financed by the town of Cherokee, under terms of a $25 million bond issue said to be the largest of its kind in the U.S.A.

When completed, the plant will be leased to and operated by Armour Agricultural Chemical Company. It will consist of six manufacturing units using common sources of power, water and natural gas. Ammonia plant capacity will be 360 short tons a day and from this will be produced 80 tons of urea, 250 tons of N solution, 300 tons of nitric acid and 250 tons of ammonium nitrate.

Phillips Ships Refrigerated Ammonia by Barge

Anhydrous ammonia at −28°F and atmospheric pressure is being shipped by Phillips Petroleum Company in two refrigerated barges between Adams Terminal on the Houston Ship Canal and East St. Louis, Ill., where two cone-roof storage tanks have been installed, each holding 15,000 short tons of anhydrous ammonia at atmospheric pressure and −28°F.

The open hopper - type barges built by Avondale Shipyards Inc. have two horizontal cylindrical tanks, 16 feet in diameter and 242 feet long of special carbon steel that is ductile at low operating temperatures, and is capable of carrying about 1,830 tons of ammonia. Capacity can be raised by towing another box-type barge between the two barges. At the Adams Terminal the ammonia is loaded at about 40 p.s.i.g. and 26°F. During transit, vapour from the top of the cargo tanks is compressed, condensed and returned as liquid ammonia to the cargo tanks by direct refrigeration system which cools the ammonia to −28°F. Refrigeration capacity can handle heat gained from the atmosphere and can lower the cargo temperature from +26° to −28°F in six days.

The specially designed barges of lead can be expected to produce substantial savings in both investment and operating costs, although shipments of ammonia in this form may not always be more economical than its conventional movement under pressure. If new storage at terminals has to be built, it is claimed that fully refrigerated storage and barges would be more economical. One of the main factors affecting capital costs is the substantial saving in the amount of steel in barges and tanks working with a maximum pressure of 65 p.s.i.g. as compared to working at 250 p.s.i.g.

The first of two 242 feet tanks, which can each carry 1,700 tons of anhydrous ammonia, is lowered into the barge owned by Phillips Petroleum Company. Both tanks and the barge have been built by Avondale Shipyards Inc., New Orleans

Olin's Hydrazine Plant Operating

Anhydrous hydrazine rocket fuel is being produced by Olin Mathieson Chemical Company at Saltville, Va., in a new $15 million plant.* Built by Olin, the plant is operated for the U.S. Air Force, under a $25 million contract and Olin will deliver hydrazine to the Air Force for the next three years.

Capacity of the new plant is classified but it is claimed to be the world's largest hydrazine unit. Olin already produces hydrazine at a $3 million plant at Lake Charles, La., with an annual capacity of 4 million lb. Output of the new plant will be used as fuel for the Titan II intercontinental ballistic missile. Hydrazine is mixed with the unsymmetrical dimethylhydrazine.*

*Nitrogen 11 May 1961, Current Events.

WEST GERMANY

Treatment of Ammonia Liquor

Bergwerksverband G.m.b.H. has been conducting experiments with aqueous ammonia liquor from coke ovens containing hydrogen sulphide and hydrogen cyanide using various pressures, temperature, air/solution ratios, HCN and ammonia content.*

The liquor containing H_2S and HCN is heated to 50 to 100°C, preferably to 60° to 90°C, with oxygen or air to convert the cyanide at least partially to ammonium thiocyanate, thereby preventing or diminishing corrosion during subsequent deacidification of the aqueous ammonia. The reaction may take place in a relatively small tower e.g. 2.5 metres high, packed with saddles or Raschig rings, at atmospheric pressure or above. Excess of oxygen may produce thiosulphate.

*British Patent 848,834

NETHERLANDS

Ammonia Plants at Delfzijl

Planning to establish a nitrogen fertilizer factory at Delfzijl, in Groningen province, as a joint venture are Bataafse International Petroleum Maatschappij N.V. (Royal Dutch Shell Group), the Koninklije Nederlandsche Hoogovens (Royal Dutch Blastfurnaces), Koninklije Nederlandsche Zoutindustrie (KNZ-Royal Dutch Salt Industry). Delfzijl is the site of the newly-discovered large reserves of natural gas which will be the main raw material for ammonia synthesis. Most of the ammonia produced will be used in the manufacture of nitrogenous fertilizers. Nederlandsche Aardolie Maatschappije N.V., owned by Royal Dutch and Esso, has applied for concession to exploit the gas.

Bataafse Petroleum and Hoogovens are already interested in fertilizer production at Ijmuiden as shareholders of Mekog N.V. which produces nitrogen fertilizers based on coke oven gas.

Staatsmijnen (Dutch State Mines) is also planning to expand fertilizer capacity by establishing a plant near Delfzijl based on natural gas. Negotiations between this company and Bataafse, KNZ and Hoogovens are said to be taking place to find a way of combining the two projects in a four-company joint venture. Also, agreement has been reached in principle by KNZ with Mekog to set up a holding company incorporating the Albatros and Mekog interests.

The Albatros-Mekog joint venture would produce fertilizers such as Shell No. 1 and 2 compounds at Pernis.

NORWAY

Ammonia Plant for Norsk Koksverk

Norsk Hydro A/S, already engaged in an expansion programme at its Glomfjord works whereby ammonia capacity was raised to 70,000 tonnes N in 1961 and will be raised further to 86,000 tonnes N by 1964-65, will also dispose of 70% of the output from the projected ammonia plant of Norsk Koksverk at Mo-i-Rana, following the conclusion of a 12-year agreement with the Norwegian Government. The Mo-i-Rana plant which is Government sponsored and in respect of which Norway's Storting is to guarantee the capital cost of 60 million Kroner (£3 million) is being built in conjunction with a coke-oven complex. Its projected capacity is 50,000 tonnes a year NH_3, due by the end of 1963. No decision has so far been made with regard to the disposal of Norsk Koksverk of the uncommitted balance of 15,000 tonnes a year NH_3 nor in respect of ammonium sulphate production and the installation of a sulphuric acid plant based on Bleikvassli pyrites concentrates.

CZECHOSLOVAKIA

Slow Expansion of N Production

When the report for the first three-quarters of 1960 of the Czech State Planning Commission was discussed at a recent sitting of the Czech Parliament, the Government criticised the irregularity of "plan realisation" in the country's nitrogenous fertilizer industry.

Production of Czechoslovakian nitrogenous fertilizers in 1960 amounted to 139,450 tonnes N, only 4.9% (6,510 tonnes N) more than in 1959. In addition some 34,000 tonnes N in the form of various nitrogenous fertilizers was imported. By 1965—the end of the Third Year Plan—Czechoslovakia hopes to produce 292,000 tonnes (N) nitrogenous fertilizer, of which 48% will be ammonium nitrate, 20% ammonium sulphate and 32% of other types.

Complex fertilizer production has begun for the first time in Czechoslovakia at the Lovosice nitrogen works, and on a semi-industrial scale at the Semtin chemical works near Pardubice. The chemical combine which is being erected at Sala, Southern Slovakia, will be the largest nitrogen producer in the country; output by 1963 from this one works is to exceed total current Czech production. Natural gas from nearby deposits will be used as raw material, and output will include lime ammonium nitrate, urea and mixed fertilizers.

Another nitrogen works and a new urea plant are to be erected in Slovakia by 1965, and in East Slovakia a third nitrogen plant is being built in conjunction with Czechoslovakia's most important capital project. Most of the surplus gas from the combine's coke oven plants will be used to make nitrogenous fertilizers.

POLAND

Urea Plant Ordered From Power-Gas

A contract for a urea plant for Poland to produce 500 tons a day of prilled product for fertilizer use and a small proportion used directly as cattle feed has been received by the Power-Gas Corporation Limited of Stockton-on-Tees, a member of the Davy Ashmore Group. The contract valued at £1½ million has been made on a deferred payment basis and is the first contract gained by Power-Gas in Poland.

The urea plant will be at an existing ammonia plant in Poland at Tarnow and will in fact be the first major complete process installation at this site to be supplied by any country outside Eastern Europe and will be the first of five to be built under the current Polish Five-Year Plan.

The plant will be a complete recycle unit in two streams and will employ the Japanese Toyo Koatsu process* for which Power-Gas is the British Licensee. It will be the first application of the Japanese process outside Japan, although in Japan similar plants with a total daily capacity of approximately 1,500 tonnes are already installed. Advantages of the Toyo Koatsu process are the production of low-biuret content crystal product and complete flexibility in production of both crystals and prills.

Delivery will be effected in the early part of 1963 and the plant will be put into operation by Power-Gas and Toyo Koatsu personnel. Most of the equipment will be supplied from the U.K.

Power-Gas has also received recently orders for other plants in Eastern Europe and is associated with Werkspoor N.V. which has orders for three urea plants for the U.S.S.R. In addition the Stockton company is now preparing a number of proposals for process plant for Poland and other Eastern Europe countries.

In the case of Werkspoor contract Power-Gas which is building the crystallizer, is guaranteeing the biuret content of the urea crystals to be less than 0.08%, based on a feed liquor containing 0.3% biuret. Crystallization will be effected at a temperature of 50°C using the Krystal process. A Krystal plant originally designed for the production of ammonium sulphate is being used by Norsk Hydro in Norway for production of urea crystals and the Werkspoor unit and the new Polish Plant will employ similar plant.

The Krystal plant is run continuously without purge until an input of 500 tons of urea is received and then all the liquor is returned to the prilling plant. At the start of the operation, the biuret content of the urea crystals is approximately 0.05% but this slowly increases with processing to 0.15%. If urea crystals containing the higher biuret content

* NITROGEN 1959, No. 4, page 27

are washed by centrifuge the biuret content can be reduced to 0.1%. Power-Gas estimated that at the end of a production run the biuret content of the mother liquor is about 2%. Crystal size is within the range of 1.02mm.

JAPAN

Kyowa Group Reorganization and Expansion

Revised plans have been announced and submitted to the Ministry of Trade and Industry by Kyowa Fermentation Industries Ltd. in respect of expansion of ammonia and nitrogen fertilizer manufacture which has been co-ordinated with the requirements of Ube Soda Company and rationalisation of output.

Kyowa Fermentation operates at Ube an ammonia plant with an annual capacity of 52,800 tonnes NH_3 on which is based the manufacture of 34,200 tonnes urea and 54,600 tonnes ammonium sulphate. Ube Soda which obtains its ammonia supplies from Kyowa, decided to rationalise production to change to the ammonium chloride soda process with the result that its ammonia needs would rise to 52,300 tonnes NH_3. To meet this demand and Kyowa's own requirements it was decided to build a new 100 tonnes NH_3 a day plant and because of more favourable raw materials and site facilities the new plant will be at Nakajo and not at Ube as formerly envisaged. When reorganised and expanded the group's facilities which significantly will no longer produce synthetic ammonium sulphate from ammonia but exclusively urea will be as follows:

Kyowa Fermentation will cease to manufacture urea and ammonium sulphate at the Ube works, but an ammonia liquefaction plant will be installed at a cost of 50 million yen, to supply 52,320 tonnes a year of liquid ammonia to Ube Soda.

Kyowa Gas Chemical, a subsidiary of Kyowa Fermentation is installing at Nakajo a 16,000 tonnes a year methanol and a 32 tonnes per day acetylene plant based on natural gas which will be completed by March 1962. These productions will yield waste gas at a daily rate of 202,000 cu. metres which will be utilised in the manufacture of 100 tonnes NH_3 a day ammonia. Chemical Construction Corporation of New York will build the ammonia plant as well as an urea plant with a daily capacity of 91.2 tonnes product. Plant to produce 7,000 tonnes annually of by-product ammonium sulphate and 1,555 tonnes of hydrocyanic acid for production of methacrylates will also be installed.

Construction work on the new projects which started in May is scheduled to be completed by May 1962 and is estimated to entail expenditure of 2,660 million yen (£26 million).

EGYPT

Fertilizer Operation in Aswan

One of the largest plants of its kind in the world and one of the greatest industrial units in the Middle East is the lime ammonium nitrate plant at Aswan operated by Kima Egyptian Chemical Industries. The plant was constructed by the Franco-German consortium composed of Compagnie Industrielle de Travaux of Paris, Badische-Anilin und Soda-Fabrik AG. of Ludwigshafen on Rhine and Friedrich Uhde G.m.b.H. of Dortmund, West Germany; the latter is the leading member of the consortium and is responsible for the construction of the plant.

Construction began in the autumn of 1957 and the first stage of the plant was turned over to Kima Egyptian Chemical Industries in October 1960 after a trial period of 30 days. By January of this year commissioning trials for a further two units were completed and the fourth unit is now being commissioned by Uhde.

When the consortium was awarded the contract for Aswan, in March 1956, daily production capacity of calcium ammonium nitrate was to be 1,200 tonnes but this projected capacity was later extended in 1958 to 1,600 tonnes a day. The nitric acid plant—yielding 60% HNO_3 acid—is now operating at its rated capacity of 132 tonnes N a day. Current output of the product is about 1,300 tonnes of 20.5% N lime ammonium nitrate.

In May the Egyptian Government is reported to have decided to impose a ban on "nitrogen fertilizer imports" but it is believed that this refers only to lime ammonium nitrate of which imports in 1958 totalled 448,100 tonnes and in 1959 271,400 tonnes, and are estimated at 200,000 tonnes in 1960.

Staatsmijnen Nitrogen Production Increased 6% in 1960

NITROGEN production at Staatsmijnen in Limburg (Dutch State Mines) totalled 229,000 tonnes in 1960, an increase of 6% over the previous year. The greater part of this production was used in the manufacture of fertilizers, some 995,000 tonnes of nitrogenous fertilizers being produced.

Sales in the fertilizer season 1959-60 increased notably compared with those in the previous fertilizer year. Of Staatsmijnen total production, 52% (213,000 tonnes) was delivered to the domestic market. The methane-cracking plant came into operation at the end of 1959, provided raw material for ammonia manufacture and helped to reduce its cost of production.

Fertilizer Production

Production capacity for urea has increased considerably—by 20% to 82,000 tonnes product—over the preceding year. The nitrogen content of calcium ammonium nitrate, Staatsmijnen's most important fertilizer, has been raised from 20.5% N to 23% N and this has resulted in lower unit freight costs. Production of NPK fertilizer mixtures has also increased and greater sales have resulted.

Consumption

Total Dutch consumption of nitrogenous fertilizers, according to Staatsmijnen's report, amounted to 213,000 tonnes in 1960, compared with 199,000 tonnes in 1959. The increased consumption was mainly due to the greater use of nitrogenous fertilizers on grassland.

Exports

In 1960 the Dutch nitrogen industry exported 220,000 tonnes N, approximately 920,000 tonnes of fertilizers, and of this total Staatsmijnen supplied some 48%. Exports of urea increased by 50%.

Prices

Due to increased production of nitrogenous fertilizers, competition on the world market has grown and prices have tended to be lower, both on domestic and on export markets.

Caprolactam

Production and sales of caprolactam increased in 1960 by about 50% by virtue of the demand for this product both in the Netherlands and in various export markets. Staatsmijnen reports that more than 35% of total caprolactam production has been exported. Quality of the product has been markedly improved since the start of production in 1952.

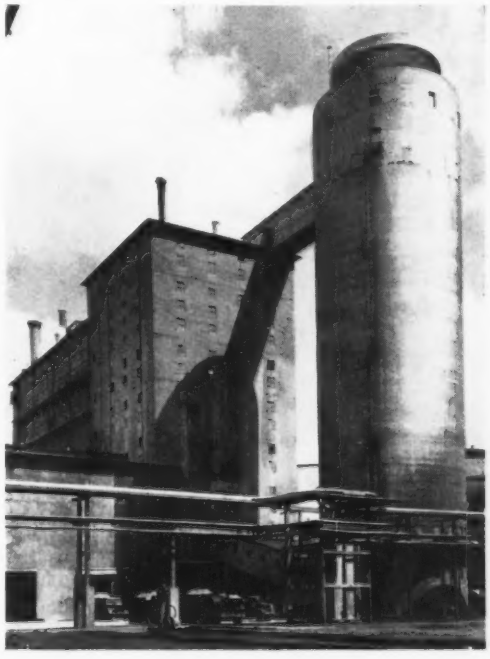
Staatsmijnen and Dow Chemical Company of the U.S.A. are building a phenol plant on Staatsmijnen's site at Nieuwe Waterweg, Rotterdam, which will have an annual capacity of 25,000 tonnes. Part of the production will be used by Staatsmijnen for the manufacture of caprolactam.

Sulphuric Acid Production

An old chamber sulphuric acid plant, which was built in 1930, was dismantled in 1960. Production of sulphur dioxide and sulphuric acid in the contact plant, was increased by 50%. Both these sulphur products are used mainly in the production of caprolactam. A third sulphur-burner has been installed and is in operation.

Plant Contracts

In 1960 Staatsmijnen subsidiary, Stamicarbon N.V. secured contracts for five urea plants with a total capacity of 2,000 tonnes a day. A contract has also been obtained for a nitric acid installation.



Fertilizer plant of Staatsmijnen at Geleen. On the right is the prilling tower

Montecatini Reports Steep Rise in Nitrogen Fertilizer Production

AMONG the Montecatini group activities which include mining, electricity generation, production of inorganic and organic chemicals and fertilizers results reported for the manufacture of nitrogenous fertilizers show that production rose 30.1%. The company's output of 233,735 tonnes N represents over 42% of total Italian fertilizer nitrogen.

The company's president, Dr. Carlo Faina, once more drew attention to the low prices of fertilizers in Italy, which are now fixed by the C.I.P. (Commissione Industriale dei Prezzi). Current Italian fertilizer prices, he said, were lower than domestic prices of any other producing country in the world and he deplored the official attitude in this respect. He emphasised the company's intention to maintain economic production employing the most modern techniques.

Complexes

The company's modernisation and conversion to manufacture of complex fertilizers was prominent in 1960. Plants manufacturing complex fertilizers with low and medium content were completed at Vercelli, Castel Guelfo and Barletta, and the new plant for high concentration complexes was brought on stream recently at Porto Marghera. Eventually the company's development programme provides for the manufacture of complex fertilizer at the above-named plant as well as at Porto Empedocle, Orbetello, Monte Marciano, Legnano and Crotone.

Foreign Subsidiaries

Production by Cie. Nederlandaise de l'Azote was increasing. In Belgium, Montecatini decided to relinquish its participation in Soc. Ammoniaque Synthetique Derivé. At the Lima plant of Fertilizantos Sinteticos S.A. production is about to start and favourable results are expected.

The Montecatini group activities in the patents field has been notable. There are now 277 nitrogen plants throughout the world employing the Fauser-Montecatini process representing a total output of some 4 million tonnes of pure nitrogen. They include the Neyveli plant in India which was projected by Montecatini and which will incorporate the largest urea plant in the world.

Finances

Montecatini achieved a net revenue of 13,123 million Lire in 1960, 5.7% more than in 1959. Gross revenue was 167,095 million Lire, an increase of 2.5%. At a subsequent extraordinary meeting a proposal for the issue of 5,000 million in shares of Lire 1,000 carrying interest at 5½% and repayable after 20 years, thereby raising the share capital by 150 million Lire, was carried unanimously.

Table

	1956	1957	1958	1959	1960
Nitrogen fertilizers (tonnes N)	191,456	196,306	186,100	179,412	233,735
Complex fertilizers (tonnes plant nutrients NPK)	53,946	55,916	59,401	101,246	148,602

Scottish Agricultural Industries Expand Ammonium Phosphate Capacity

SCOTTISH AGRICULTURAL INDUSTRIES LIMITED, a subsidiary of Imperial Chemical Industries Limited, is to spend £1¼ million on the conversion of Sandilands Works, Aberdeen, from the production of compound fertilizers based on single superphosphate to the production of ammonium phosphate and the more concentrated compounds which can be made from it. This development is a result of the trend towards increasing demand for concentrated complete fertilizers which enabled the company's Leith Works to operate throughout 1960 at full capacity.

In the meantime, further relatively small expenditure is being incurred to enable the Ayr Works to produce limited amounts of concentrated fertilizers. Some sales of ammonium phosphate are being made to other compound fertilizer manufacturers.

Although demand for fertilizers based on superphosphate is still considerable it is diminishing and the works at Ayr and at Dyce in Aberdeenshire will be sufficient to satisfy it in the future.

Research and Development

S.A.I.'s research department has devoted much of its recent efforts to ammonium phosphate and high quality ammonium phosphate-based compounds, which have already been produced experimentally at its Aberdeen and Ayr works in plant normally used for the production of more conventional types of granular compound.

Finances

During the financial year to 30 September 1960 the consolidated profit for the company was £688,382. After deducting £10,599 attributable to minority interests in subsidiary companies and £308,055 for dividends, the profit retained in the group is £369,728 compared with £324,521 in 1959. Sales in 1960 amounted to £24,836,744, compared with £24,863,605 for 1959.

Monsanto Reports Highest-Ever Ammonium Nitrate Sales

EARNINGS for Monsanto Chemical Company decreased by 9.3% in 1960 compared with 1959 despite a 2% increase in sales. The decrease is attributed to declining selling prices, increased operating expenses, and higher raw material and labour costs. Total income for 1960 was $900,525,000 compared with $885,232,000 for 1959. After making all deductions for raw materials, salaries and wages, depreciation, etc., the net income was $67,807,000 ($74,765,000) of which $25,659,000 ($24,914,000) was distributed as cash dividends to shareholders, leaving $42,148,000 ($49,851,000) to be carried forward.

At special meetings held on the 16 January 1961 an agreement was reached with American Viscose Corporation for the transfer to Monsanto of the former's 50% equity in The Chemstrand Corporation which now becomes a wholly-owned subsidiary of Monsanto. Founded in 1949 jointly by Monsanto and American Viscose, Chemstrand is the U.S.A.'s second largest producer of nylon yarn and acrylic fibre. By 1960 it was operating three plants in the U.S.A. and had a wholly-owned subsidiary in Northern Ireland. It also has important minority interests in acrylic fibre companies in Italy and Japan.

Agricultural Chemicals

During 1960 a new operating division to handle agricultural chemicals was formed, consolidating responsibility for all research, development, manufacturing and marketing for farm chemicals. This work was formerly shared by the organic and inorganic chemicals divisions.

Sales of ammonium nitrate were the highest ever in 1960 and urea sales were twice the 1959 figure. Improvements have been made in both products, but pressure from low-priced imports, especially of urea, is reported to present an increasing problem.

In the light of increasing use of anhydrous ammonia as a fertilizer of about 11% annually, Monsanto has added to its ammonia capacity. New field stations for ammonia distribution were installed in several areas.

At the El Dorado, Arkansas, plant a new feed-grade urea has been introduced which is claimed to provide a low-cost, concentrated source of protein. Capacity for MHA, a protein supplement for animal feeds, has been increased 50% by the addition of a new unit at Nitro, West Virginia. Also under construction at Nitro is new capacity for Santoquin, an antioxidant that preserves the nutritive value of feeds and dehydrated foliage.

The agricultural chemicals division also markets ammonium nitrate as an ingredient of nitro-carbo-nitrate blasting agents. Sales for this application in 1960 were 25% higher than in 1959.

Inorganic Chemicals

Sales of phosphorus chemicals were the highest ever in 1960. Phosphoric acid capacity was enlarged at Kearny, New Jersey, and a new plant was installed at Addyston, Ohio, to serve a large market in that area. Increased sales are reported of chlorine carriers for dry bleaches, sanitation agents, scouring powders and swimming pool chlorinating agents, and two new ones, ACL 59 and ACL 60, became available in commercial quantities from expanded facilities at Everett, Massuchesetts. It is reported that these derivatives of trichlorocyanuric acid are being well received.

Associated Companies

Mobay Chemical Company, owned jointly by Monsanto and Farbenfabriken Bayer AG. of Western Germany, completed its third expansion of production facilities for toluene diisocyanate (TDI) in July 1960, raising annual capacity to over 25 million lb. A fourth expansion, now under way, will bring annual production to 40 million lb. At Mobay plant at New Martinsville, W.Va., additional property has been bought for the construction of facilities to produce dinitrotoluene, a basic ingredient for TDI.

Monsanto's urea prilling tower

W. R. Grace's Sales and Profits from Fertilizers Rose in 1960

"While there are many uncertainties in the economic outlook for the immediate future, we estimate that our 1961 results should surpass those of 1960."

J. Peter Grace
President
W. R. Grace and Company

ALTHOUGH consumption of plant nutriments used in fertilizers in the U.S.A. has been increasing at an annual rate of about 5% in the past five years, the rate of increase for the newer concentrated fertilizers as produced by W. R. Grace and Company's Nitrogen Products and Davison Chemical Divisions has been much greater. In 1959 and 1960 these two divisions undertook major expansion programmes which are continuing in 1961.

Ammonia Plant Expansion

Nitrogen Products Division, which in 1959 raised urea capacity at Memphis, Tenn., from 50,000 to 100,000 short tons, in 1960 operated the expanded plant successfully for the first full year. Recently the new plant's ammonia capacity has been increased by 60%, but the 1960 results do not, of course, reflect the benefit of this expansion. The Division's sales and profits increased in 1960.

Demand for High-Analysis Fertilizers

Increasing demand for high analysis fertilizers necessitated expansion of capacity of the Bartow, Fla., plant of Davison Chemical Division which mines phosphate rock and converts into triple superphosphate, diammonium phosphate and related materials. Additional capacity for sulphuric and phosphoric acids is being built which will permit a higher output of finished products.

Overseas Activities

Nitrogen Products Division provides management supervision for Federation Chemicals Limited, which is producing ammonium sulphate and urea in Trinidad, West Indies, and for Caribe Nitrogen Corporation, Puerto Rico, which produces ammonium sulphate. W. R. Grace owns 49% of the stock in each of these companies and has options to purchase additional amounts. Both plants are working satisfactorily but low world prices for their products have caused operations to be unprofitable. There are signs, however, the company reports, of improvement.

Finances

Consolidated net income of W. R. Grace and Company in 1960 was $16 million compared with $16.466 million in 1959, corresponding to $3.22 ($3.35) per share.

Chemicals earnings rose 11% and accounted for 76% of the company's total earnings. Associated in the improvement in the chemicals results was the rising demand for agricultural chemicals, particularly the high analysis types.

African Explosives and Chemical Industries' Increased Fertilizer Sales

DURING 1960, fertilizer and agricultural products sales of African Explosives and Chemical Industries Limited increased over those recorded in 1959 in the Union of South Africa and in the Federation of Rhodesia. Sales of explosives also reached a record total.

Delays in Ammonia/Urea Project

In his review, the chairman, Mr. H. F. Oppenheimer, reported that in November 1960 the new ammonia/urea project was officially opened. It had been hoped that this complex would be in full production before the end of the year. Unfortunately, serious breakdowns of certain important items of equipment have occurred and will have the result of delaying the full utilization of the plant until early 1962. A.E. and C.I. should be operating shortly at 75% of capacity. The full contribution from this exceptionally important new investment will, therefore, not make itself felt in the profits until early 1962.

Active Policy

Mr. Oppenheimer emphasises in his statement the advantage which the company continues to derive from its close association with Imperial Chemical Industries Limited, owners of one-half of A.E. and C.I.'s share capital. I.C.I. is not hesitating to invest on a larger scale in Southern Africa and continues to provide technical know-how. A number of important projects both in the Union and Rhodesia are at present under consideration and both the major shareholders in A.E. and C.I.—I.C.I. and De Beers Industrial Corporation Limited—are agreed that the active policy followed over the past 10 years should be continued.

Finances

In the 10 years from 1951 to 1960 the funds employed in the group have increased from £14,830,000 to £50,101,000 including £6,468,000 that has arisen from revalution of assets in 1957. Over the same period profits after tax have increased to £3,632,000—three times the 1957 figure of £1,197,000

Group net profit for the year after providing £452,209 for taxation, including adjustments of £51,906 in respect of previous years, £796,000 for deferred taxation and £88,225 in respect of outside shareholders' interests therein, is £3,631,631, which, with the balance of £540,872 brought forward from 1959, gives a total consolidated profit of £4,172,443.

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This is a model of the Giammarco-Vetrocoke plant which is one unit of the fertiliser factory Simon-Carves are building in Madras for East India Distilleries and Sugar Factories Ltd.

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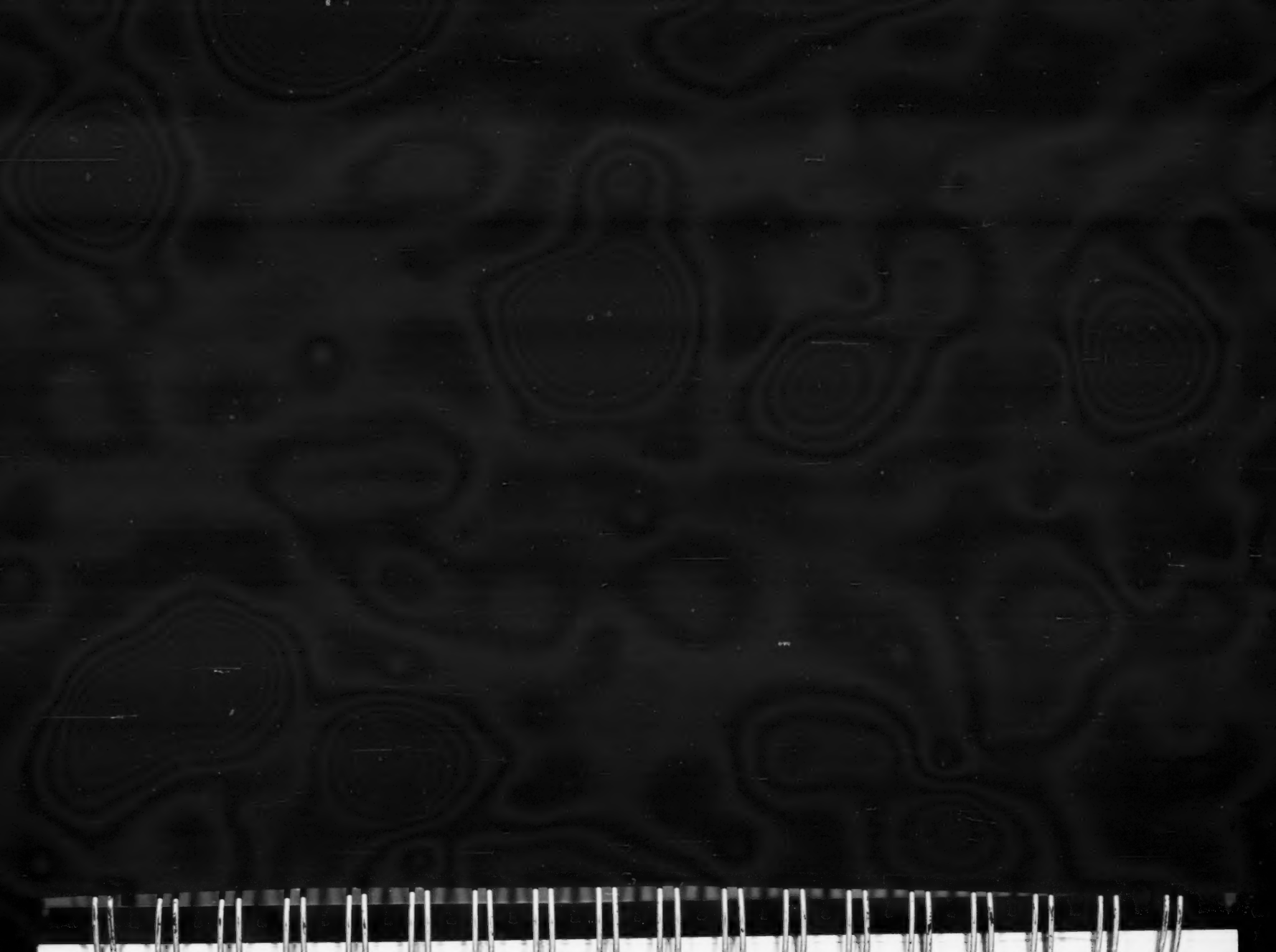
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